

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FISCAL YEAR 1996 ANNUAL PERFORMANCE REPORT
TO
HISTORICALLY BLACK COLLEGES AND UNIVERSITIES (HBCU)

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	2
PART I-A: SUMMARY OF AGENCY AWARDS BY CATEGORY: FY 1996 Discretionary Awards (dollars in thousands)	3
PART I-B: SUMMARY OF AGENCY AWARDS BY CATEGORY: FY 1996 Legislated or Formula-Driven Awards (dollars in thousands)	4
PART I-C: FY 1996 SUMMARY OF AGENCY AWARDS TO HBCU'S, BY INSTITUTION	5
FY 1996 Federal Agency Awards to Institutions	6
FY 1996 Summary of NASA Awards to HBCU's, by Installation	10
PART II: AWARDS AND NARRATIVE INFORMATION	
Research and Development	11
Program Evaluation	43
Training	46
Facilities and Equipment	52
Fellowships, Internships, Traineeships, Recruitment, and Intergovernmental Personnel Act (IPA)	53
Student Tuition Assistance, Scholarships, and Other Aid	56
Direct Institutional Subsidies	58
Third-Party Awards	59
Private-Sector Involvement	61
Administrative Infrastructure	62
Other Activities	63
NASA FIELD INSTALLATION SUMMARIES	64

EXECUTIVE SUMMARY

The NASA association with HBCU's began before man first stepped on the moon, and this productive relationship has been strengthened through Presidential, Congressional, and NASA Administrator directions. We seek full participation of all Minority Institutions in the NASA-sponsored research and education community, striving for academic excellence and outstanding achievements while advancing America's leadership in a competitive scientific and technological global economy. During fiscal year (FY) 1996 numerous cooperative relationships between NASA and HBCU's were initiated and expanded by agency managers.

NASA's investment in HBCU's declined from a planned investment of \$46 million in FY 1996 to an actual investment of \$39 million in FY 1996. The decrease represents a 20 percent reduction of actual versus planned funding for FY 1996, and a 38 percent decrease from the FY 1995 level. Out of the 8 field installations and the Jet Propulsion Laboratory, 6 showed an increase in funding and 3 a decrease. The major decrease occurred at Headquarters. A large portion of the reduction in funding resulted from program realignment and the transfer of programs from Headquarters to the Centers. As one field installation has reported, "Limited budgets will continue to restrict HBCU activities. However, identification of additional fund sources will be an ongoing effort...."

Additional resources will be provided in FY 1997 through the Partnership Awards. NASA has selected 39 minority institutions to receive 65 Partnership Awards to expand educational opportunities and enhance diversity in the NASA-sponsored research and education community. The institutions were chosen based on a competitive review of concept papers submitted through the NASA installations and the Jet Propulsion Laboratory. The selected institutions are from seventeen states, the District of Columbia and Puerto Rico. The awards are for two years with a maximum of \$200,000 per minority institution.

The success of NASA supported HBCU's in FY 1996 is particularly noteworthy in the research and development activities at the University Research Centers (URC). The URC at Minority Institutions Program seeks to achieve a broad-based, mainstream, competitive aerospace research capability among the nation's HBCU's. During FY 1996, 210 professional-level investigators were involved in research projects at the URCs, including 157 faculty members, 35 research associates, and, 18 post-doctoral fellows. A total of 351 students, including 227 undergraduates and 124 graduate students, participated in these research activities. The research accomplishments were documented in 207 refereed papers or book chapters published during this time period. Significantly, 71 students were authors or co-authors of these publications. An additional 85 papers or book chapters, including 27 student authors or co-authors, were accepted for publication during this period. The broader research community was informed of this work through 291 technical presentations given at national and international conferences, including 110 presentations given by students. During the past year, the URC were able to leverage their NASA expenditures to an additional \$10,800,000 in research support from other NASA programs and from other agencies.

The Agency's success in implementing a productive HBCU plan can be directly attributed to the commitment and dedication of NASA managers agencywide. We seek to build on these partnerships and will continue to strive to meet the important goals of the White House Initiative. Our success will bring substantial benefit to NASA, the Nation, and the World.

PART I-A: SUMMARY OF AGENCY AWARDS BY CATEGORY: FY 19961. Agency: National Aeronautics and Space Administration

2. Agency Representative: Mr. George E. Reese _____
 Associate Administrator for (Signature)
 Equal Opportunity Programs

3. Total Universe of Funds for Institutions of Higher Education (IHE) \$

DISCRETIONARY AWARDS (dollars in thousands)

CATEGORY	AWARDS TO IHE's+	AWARDS TO HBCU's*	AWARDS TO HBCU's AS % of TOTAL AWARDS TO IHE's
1. Research & Development	\$664,581,777	\$28,673,495	4.3%
2. Program Evaluation	\$0	\$0	
3. Training	\$37,677,740	\$6,969,350	18%
4. Facilities and Equipment	\$0	\$0	
5. Fellowships, Internships, Traineeships, Recruitment, and IPA's	\$19,263,412	\$2,234,760	11.5%
6. Student Tuition Assistance, Scholarships, and Other Aid	\$3,935,473	\$99,407	2.5%
7. Direct Institutional Subsidies	\$0	\$0	
8. Third-Party Awards	\$0	\$1,371,530	
9. Private-Sector Involvement	\$0	\$20,000	
10. Administrative Infrastructure	\$0	\$0	
11. Other	\$47,153,222	\$101,375	.2%
TOTAL	\$772,611,624	\$39,469,917	5.1%

Daniel S. Goldin
 Administrator

 (Signature)

+ IHE=Institutions of Higher Education

* HBCU's=Historically Black Colleges and Universities

PART I-B: SUMMARY OF AGENCY AWARDS BY CATEGORY: FY 1996

1. Agency: National Aeronautics and Space Administration

2. Agency Representative: Mr. George E. Reese _____
Associate Administrator for _____ (Signature)
Equal Opportunity Programs

3. Total Universe of Funds for Institutions of Higher Education (IHE) \$

Legislated or Formulae Driven Awards (dollars in thousands)

CATEGORY	AWARDS TO IHE's+	AWARDS TO HBCU's*	AWARDS TO HBCU's AS % of TOTAL AWARDS TO IHE's
1. Research & Development	\$0	\$0	
2. Program Evaluation	\$0	\$0	
3. Training		\$0	
4. Facilities and Equipment	\$0	\$0	
5. Fellowships, Internships, Traineeships, Recruitment, and IPA's	\$0	\$0	
6. Student Tuition Assistance, Scholarships, and Other Aid	\$0	\$0	
7. Direct Institutional Subsidies	\$0	\$0	
8. Third-Party Awards	\$0	\$0	
9. Private-Sector Involvement	\$0	\$0	
10. Administrative Infrastructure	\$0	\$0	
11. Other		\$	
TOTAL			

Daniel S. Goldin
Administrator

(Signature)

+ IHE=Institutions of Higher Education

* HBCU's=Historically Black Colleges and Universities

**TOTAL FY 1996 AWARDS TO HISTORICALLY BLACK COLLEGES AND
UNIVERSITIES**

	Institutions Of Higher Education	Historically Black Colleges And Universities
DISCRETIONARY AWARDS:	\$772,611,624	\$39,469,917
LEGISLATED AWARDS:	\$0	\$0
TOTAL AWARD:	\$772,611,624	\$39,469,917

PART II - AWARDS AND NARRATIVE INFORMATION

Category 1: Research and Development

Continuing Activities

<u>HBCU/ACTIVITY</u>	<u>CENTER</u>	<u>AWARD</u>
ALABAMA		
<u>Alabama A&M University</u> Signal Processing Algorithm Sensor	DFRC	\$30,000
Center for Hydrology, Soil Climatology and Remote Sensing	HQS/OMTPE HQS/OEOP	\$957,914 \$475,136
Integrated Optics in Thin Films of Polymers & Organic Materials	LeRC	\$50,000
Development of Upconversion Materials, Lasers, and Optical Sensors	MSFC	\$164,927
Numerical Investigation in the Backflow Region of a Vacuum Plume	MSFC	\$50,168
<u>Oakwood College</u> Freetape Research	MSFC	\$29,337
<u>Selma University</u> Feasibility of Degradation of Chlorinated Solvents	HQS	\$137,600
<u>Tuskegee University</u> Center for Food Production, Processing, and Waste Management	HQS/OMTPE HQS/OLMSA HQS/OEOP	\$200,000 \$400,000 \$307,334
Fracture Morphology of Selective Polymer Systems Under Monotonic and Fatigue Loading	KSC	\$94,020
Development of Small Portable Mass Spectrometer	KSC	\$174,062
Main Engine Study	MSFC	\$93,992
A Study of the Fluid Mechanics of Reacting	SSC	\$56,214

Flows in Selected Aerospace Propulsion Devices

DISTRICT OF COLUMBIA

Howard University

Center for the Study of Terrestrial and	HQS/OSS	\$985,988
Extraterrestrial Atmospheres	HQS/OMTPE	\$1,000,000
Photochemistry of Acetylenes - Lab Studies	HQS	\$45,000
Development of Cubic Silicon Carbide	LeRC	\$20,000
Howard University/NASA Lewis Cooperative Research Studies	LeRC	\$58,001
Development and Implementation of an Adaptive Real-Time Controller for Permanent Magnet Brushless Systems	LeRC	\$70,000
Determination of Thermal State of Change in Solar Heat Receivers	LeRC	\$100,000
Free Radical Spectroscopy and Kinetics in Microgravity Combustion	LeRC	\$96,738

FLORIDA

Florida A&M University

Turbulent Measures in Supersonic Flow	ARC	\$80,000
Center for Nonlinear and Nonequilibrium Aeroscience	HQS/OA HQS/OEOP	\$700,000 \$816,555

GEORGIA

Clark Atlanta University

Chemically Derived Dense Alumina-Zirconia Composites for Improved Mechanical and Wear Erosion Properties	DFRC	\$75,000
High Performance Polymers and Ceramics	HQS/OA HQS/OEOP	\$500,000 \$969,969

Cross Sections for Electron Impact Excitation of Ions Relevant to Planetary Atmospheres	HQS	\$60,000
Computer Science Technology Task	JPL	\$254,925
Bioconversion of Waste to Nutritional Protein by Microbial Mats	KSC	\$97,740
Blended-Wing-Body Structural Technology Study	LaRC	\$15,000
Constitutive Modeling and Testing of Polymer Matrix Composites Incorporating Physical Aging at Elevated Temperatures	LaRC	\$74,248
An Adaptive Flow Solver for Airborne Vehicles Undergoing Time-Dependent Motions/Deformations	LaRC	\$160,009
Experimental and Numerical Investigation of Droplet Characteristics at Various Pressure Environments	MSFC	\$99,969
<u>Morehouse School of Medicine</u>		
The Neurolab Education Program in the Decade of the Brain	ARC	\$499,765
<u>Savannah State University</u>		
Acts for Distance Education in Developing Countries	LeRC	\$266,750
LOUISIANA		
<u>Southern University - A&M College</u>		
Learning and Generalization of Neural Networks with Applications to On-Line F-16 Reference Model	ARC	\$99,996
36-Month Multiyear Award	HQS	\$1,046,784
Liquid Phase Piezoelectric Immunosensors	HQS	\$91,801
Development and Utilization of a Multipurpose Atmospheric Corrosion Sensor	KSC	\$98,995
Intelligent Knowledge Acquisition for Interactive Software for Rocket Engine Systems Design	LeRC	\$100,001

MARYLAND

Bowie State University

Research and Development for an Information Ecology	GSFC	\$88,000
---	------	----------

Model-Based Vq for Multispectral Earth	GSFC	\$44,935
--	------	----------

Morgan State University

Morgan Network Resources Training Site	GSFC	\$619,523
--	------	-----------

Maintenance and Training Support for the ETA-10 Supercomputer	GSFC	\$250,000
---	------	-----------

MISSISSIPPI

Jackson State University

Remotely Sensed Spatial Data and Propulsion Data	SSC	\$149,210
--	-----	-----------

NORTH CAROLINA

Elizabeth City State University

Regional Network Resources and Training Site At ECSU	GSFC	\$560,000
--	------	-----------

Johnson C. Smith University

Conservation/Solution Element Method for Navier Stokes Equation, Supersonic, and Transonic Flows	LeRC	\$67,000
--	------	----------

North Carolina A&T State University

Center for Aerospace Research	HQS/OSAT	\$1,100,000
	HQS/OA	\$634,121
	HQS/OEOP	\$225,000

High Tc Bolometer Development	JPL	\$81,450
-------------------------------	-----	----------

A Space Technology Development and Utilization Program	LaRC	\$100,000
--	------	-----------

Three-Dimensional Geometric Nonlinear Contact Stress Analysis of a Two-Rivet Lap Joint	LaRC	\$8,000
--	------	---------

Computational Assessment of Fan By-Pass System Design in Advanced Duct Propulsors	LeRC	\$40,000
---	------	----------

Robust, Brillouin Active Embedded Fiber-is-the Sensor System in Smart Composite	LeRC	\$141,665
---	------	-----------

OHIO

Central State University

Scientific Data Visualization Laboratory: Research Faculty Loan	JPL	\$141,381
---	-----	-----------

A Study of Evaporation from a Binary Meniscus in Microgravity	LeRC	\$150,000
---	------	-----------

Research Laboratory for Engineering and Technology and a Beta Test Center for NPARC Code	LeRC	\$278,847
--	------	-----------

Research Facility to Study Flows Through Annular Diffusers	LeRC	\$61,146
--	------	----------

Performance Evaluation in Network-Based Parallel Computing	LeRC	\$60,995
--	------	----------

Diamond like Carbon Coatings for High Temperature Lubricant Applications	LeRC	\$50,000
--	------	----------

Wilberforce University

Research Institute for Technical Careers Center for Network Resources and Training: Transition to Independence	LeRC	\$75,000
--	------	----------

SOUTH CAROLINA

South Carolina State University

Network Resources and Training Site	GSFC	\$650,000
-------------------------------------	------	-----------

TENNESSEE

Fisk University

Center for Photonic Materials and Devices	HQS/OLMSA	\$200,000
	HQS/OSAT	\$479,266
	HQS/OSS	\$37,000

Experimental Studies on Surface-Gas Plume Interactions	LeRC	\$65,000
Linear and Nonlinear Optical Properties Carrier Dynamics and Surface Morphology	LeRC	\$75,000
Metal and Semiconductor Nanocrystals	MSFC	\$124,311
<u>Tennessee State University</u>		
NASA/TSU Network Resource and Training Site	GSFC	\$600,000
Initial Conditions on the Zero Age Main Sequence: Coronal Structures as a Function	GSFC	\$7,533
Center for Automated Space Science	HQS/OSS	\$1,177,012
	HQS/OEOP	\$322,988
Neural Network Classifiers for Digital Communications Traffic Management	LeRC	\$49,944
Melting of Solid Particles in a Fluid Under Microgravity	LeRC	\$150,000
Robust Integrated Neuro Controller for Complex Dynamic Systems	LeRC	\$74,991
TSU Research Project for Increasing the Pool of Minority Engineers	LeRC	\$66,000
Research on the Mechanical Properties of Ion Beam Deposits	MSFC	\$202,671
Sun Observations	MSFC	\$121,776

TEXAS

Huston-Tillotson College

Diversity in Advancement of Science, Engineering, and Technology in the Workforce	JSC	\$10,000
Effects of Chemical Aging of Polymers	KSC	\$137,957

Prairie View A&M University

Texas Gulf Coast Environmental Data Center	HQS	\$150,601
--	-----	-----------

Center for Applied Radiation Research	HQS/OSF	\$520,000
Orbital Debris Research Center	JSC	\$200,000
Direct Satellite Communication at Ka-Band & Experiments with NASA Advanced Communication Technology Satellite	JSC	\$75,000
Flow Boiling Enhancement for Thermal Management Systems	JSC	\$50,000
Microwave Imaging of Metal Objects	JSC	\$56,000
Fuzzy Expert System for Fault Management of Water Supply and Recovery in the ALSS Project	JSC	\$30,000
Low Cost Wide Bandwidth and High Gain Microstrip Antenna Array for Satellite and Personal Communications	LeRC	\$49,336
<u>Texas Southern University</u>		
Law of Property in Space	JSC	\$75,000
The Role of Phytoalexins in Plant Disease Development in Hydroponics	JSC	\$80,000
High Energy Cells and Batteries	JSC	\$200,000
Examination of Ionic Species in Solutions of Simulated Lunar Regolith and Selected Solvents	JSC	\$125,000
Solar Photovoltaic Refrigeration Experimentation	JSC	\$25,000
Feasibility Study for Environmental Science Institution	JSC	\$75,000
Microgravity and Sickle Cell Anemia	JSC	\$175,000

VIRGINIA

Hampton University

Development of an Ultrasonic and Fabry-Perot	DFRC	\$125,109
--	------	-----------

Interferometer System for Nondestructive
Inspection of Aging Aircraft Studies

Information Content Improvement by Hyper-Spectral Image-Impact on Chesapeake Bay	HQS	\$149,965
Research Center for Optical Physics	HQS/OSS	\$1,000,000
	HQS/OSAT	\$200,000
	HQS/OMTPE	\$542,086
American Indian Education Opportunities Program	LaRC	\$109,247
Research in Airway Science, Architecture and Physics	LaRC	\$778,620
Investigation of NO2 Removal From Small Engine Exhaust	LaRC	\$56,753
Development of Laser Materials for Lidar Systems	LaRC	\$74,591
Radiation Transport and Shielding for Space Exploration and High-Speed Flight Transportation	LaRC	\$52,000
Electrorheological Fluids - Aerospace Applications NLPN 95-104	LaRC	\$59,801
Start Up Research Effort in Fluid Mechanics MY 1/3	LaRC	\$75,000
Advanced Electromagnetic Interference and Radiation Research	LaRC	\$40,000
New NASA Research Grant - NAG 1 1789	LaRC	\$92,184
Interpretation of Lidar and Satellite Data Sets Using a Global Photochemical Model	LaRC	\$53,391
Laser Research for Tropospheric Water Vapor Measurements	LaRC	\$40,934
Distributed Bragg Region Sensors with Aerospace Applications	LeRC	\$75,000
Parallelization of Rocket Engine Simulator Software	LeRC	\$102,085

<u>Norfolk State University</u>		
A Cooperative Program for Research and Curriculum Development in Earth System Science	LaRC	\$248,504
The Growth and Synthesis, Spectroscopic Characterization of Materials	LaRC	\$248,250
Development of Laboratory Experiments for Engineering Materials, Science, and Technology	LaRC	\$10,000
<u>Virginia State University</u>		
Computer Simulation of Radiation Damage in Semiconductors and Polymer	LaRC	\$71,240

New Activities

ALABAMA

<u>Alabama A&M University</u>		
Enumeration Detection of Heterotrophic Bacteria in Potable Waters for the Space Station	JSC	\$64,000
Optical Sensors Based on Single Arm Thin Film Wave Guide Interferometer	LeRC	\$10,000
For Research Ellipsometric Measurement of Organic and Non-Linear Optical Measurements	MSFC	\$83,726
<u>Oakwood College</u>		
R/S the Development Assessment Validation and Enhancement Dave of Virtual Reality for Human Anatomy	MSFC	\$78,577
<u>Tuskegee University</u>		
A Low Cost Simulation System to Demonstrate Pilot Induced Oscillation Phenomena	DFRC	\$23,716
Investigation of Techniques for Spectral Analysis and Estimation of Turbulence Scales from Randomly	LaRC	\$35,000
Identification of Surface and Near Surface Defects	LaRC	\$99,700

and Damage Evaluation by Laser Spectle

An Experimental Investigation of Effects of Space Plasma on Spacecraft and Space Power Systems Mats	LeRC	\$55,896
---	------	----------

Manufacturing and Finite Modeling of Composite Isogrid Structure	MSFC	\$50,000
--	------	----------

DISTRICT OF COLUMBIA

Howard University

Characterization, Evaluation and Fabrication of High Temperature Superconducting Materials	GSFC	\$213,000
--	------	-----------

Implementation of Reduced Order H Robust Control Laws for Expendable Launch Vehicles	LeRC	\$75,164
--	------	----------

Advanced Intelligent System Application to Load Forecasting and Control for Hybrid Electric Bus	LeRC	\$94,500
---	------	----------

FLORIDA

Florida A&M University

A Cooperative Research Program in Aeronautical Information Science Technologies	ARC	\$214,929
---	-----	-----------

Multilayer Thin Film Capacitors for High Performance Applications	JPL	\$105,184
---	-----	-----------

Micromechanical Characterization and Texture Analysis of Direct Cast Titanium Alloy Strip	LaRC	\$99,462
---	------	----------

Cubic Boron Nitride Alphasolvaic Devices	LeRC	\$89,505
--	------	----------

Labile and Stable Soc Pools Revealed by C-14 and C-13 Signatures	SSC	\$96,832
--	-----	----------

GEORGIA

Clark Atlanta University

X-Ray Diffraction Studies of Structural and Thermochemistry of Alkaline Earth Oxide Coated Thermino	LeRC	\$46,323
---	------	----------

Modeling and Testing of Hybrid Titanium Composite Laminates at Normal and Elevated Temperatures	LeRC	\$59,706
The Henry Cecil Ranson McBay Chair in Space Science	LeRC	\$750,000
Growth and Characterization of III-V Semiconductors for Device Applications	LeRC	\$99,912
Study of Long Term Durability of Polymer Matrix Composites for High Temperature Applications	LeRC	\$50,000
<u>Morehouse School of Medicine</u> Space Medicine and Life Sciences Research Center	HQS/OLMSA	\$1,368,025
Cellular Response to Hypogravity & Hypogravity Stress	JSC	\$40,000
<u>Morris Brown College</u> Internet Network Resources of Science, Mathematics, Engineering and Technologies	MSFC	\$191,854
LOUISIANA		
<u>Southern University - A&M College</u> The Advanced Thin Ionization Calorimeteratic Balloon Experiment	GSFC	\$60,000
Space Communication and Info. Research: Improved Space Link Performance Via Concentrated Forward-Error	HQS	\$200,000
Fractographic Studies and Analyses in Data Base Documentation and Development	KSC	\$50,000
Inlet Distribution and Surge/Stall Instability in Axial Compression Systems	LeRC	\$27,000
Development of Integrated Methodology for Engine Component Design and Optimization	LeRC	\$93,000

MARYLAND

<u>Bowie State University</u> Automation of Scheduling of Orbit Determination Programs	GSFC	\$108,570
--	------	-----------

<u>Morgan State University</u> Trending Analysis and Classification of Signals for Aerospace Application	GSFC	\$10,000
--	------	----------

MISSISSIPPI

<u>Jackson State University</u> System Definition and Object Oriented Programming for a Rocket Engine Numerical Simulation	LeRC	\$94,676
---	------	----------

NORTH CAROLINA

<u>North Carolina A&T State University</u> On the Previewed Control Action for Aircraft Flying Qualities	DFRC	\$50,000
--	------	----------

Dynamics of Mas Transfer in Close Interacting Binaries	GSFC	\$31,000
---	------	----------

Fault-Tolerant and Self Checking Logic System	JPL	\$106,271
---	-----	-----------

Assessment of Large Deformation in Multiple Delamination Composites	LaRC	\$60,000
--	------	----------

Phenylethynyl Containing Polyarylene Ethers/Polymides Resin Infiltration of Composites	LaRC	\$100,000
---	------	-----------

Research and Development Total		\$28,673,495
---------------------------------------	--	---------------------

NARRATIVE

NASA is an investment in America's future, boldly expanding frontiers in air and space to inspire and serve America and benefit the quality of life on Earth. Our mission is to advance and communicate scientific knowledge and understanding, explore, use and enable the development of space, and study, develop and transfer aerospace technologies. The Agency's strategic planning has separated our programs into the following four Strategic Enterprises: Mission to Planet Earth; Space Science; Human Exploration and Development of

Space; and Aeronautics. Continued support in achieving these Enterprises' objectives is provided by research that is conducted by universities throughout the country, including approximately 30 HBCU's. Research in basic areas applicable to the long-term goals of the various NASA Program Offices is usually conducted by participating universities.

One of NASA's objectives is to involve HBCU's in the performance of research projects in collaboration with NASA Headquarters and Field Installations. NASA has established numerous relationships with HBCU's and will continue the following programs:

HBCU RESEARCH CENTERS

The original seven URC's (formerly called HBCU Research Centers), established in 1991, were awarded 5th and final year funding during FY 1996. The HBCU Research Centers continue to foster new science and technology concepts, expand the Nation's aerospace research and development, develop mechanisms for increased participation by faculty and students in mainstream research, and have developed infrastructures to help increase the production of disadvantaged students with advanced degrees in NASA-related fields. These proposals were subjected to extensive reviews by specially-assembled teams of experts from both within and outside of NASA. Each review team then conducted an on-site review at the university campus, before making their recommendations. As a result, 6 of the 7 HBCU Research Centers were awarded a second 5 years of funding. The seventh Research Center was given a 1-year provisional award due to unresolved managerial issues, and will be reconsidered in FY 1997 for an

additional 4 years of funding. The 4 HBCU Research Centers first selected in FY 1995 were continued in FY 1996 for their second year of funding.

Together, the 11 HBCU Research Centers achieved the following outcomes in Summer 1995 and Academic Year 1995-96:

- 210 Faculty members and research associates conducted NASA-related research at URC's.
- 351 Underrepresented Minority Students participated in URC research.
- 87 degrees were awarded to Underrepresented Minority Students, including 59 Bachelor's Degrees, 24 Master's Degrees, and 4 Doctoral Degrees.
- 69% of the students receiving degrees went on for the next degree, or accepted employment in a NASA-related field.
- 292 Refereed papers and/or book chapters were published or accepted for publication, including 98 students as authors or co-authors.
- 375 Technical presentations were given, including 110 by students.
- \$10.8M was leveraged for this 12-month period in research funds from sources outside the NASA minority university research and education program.
- 5 patents were disclosed, applied for, or awarded.
- 7 commercial products were under development or marketed.

HBCU RESEARCH CENTER FY 1996 HIGHLIGHTS

Alabama A&M University

Center for Hydrology, Soil Climatology and Remote Sensing (HSCaRS).

The initial research thrust of HSCaRS is to develop a comprehensive research program investigating hydrologic processes with emphasis on remote sensing measurements and modeling of soil moisture. The objectives are threefold: first, to develop a measurement/modeling strategy from low resolution microwave data to derive soil moisture profile information and to determine its variability on a range of spatial scales; second, to develop a precise, inexpensive, *in situ* technique for measuring soil moisture to facilitate ground truth of remotely sensed data and validation of global and regional climate change models; and third, to take knowledge from hydrologic modeling coupled with evolutionary computing techniques to model and visualize soil moisture, soil erosion, and contaminant transport through soils and within water bodies.

RESEARCH ACCOMPLISHMENTS

Our research efforts are grouped into four major areas: Hydrology/Hydrologic Modeling (H/HM); Remote Sensing/GIS (RS/GIS); Sensor Development (SD); and Evolutionary Computing (EC). Several projects were initiated under these subject areas during 1996, which produced a number of publications and presentations.

Hydrology/Hydrologic Modeling (H/HM)

The most significant research accomplishment this year was the establishment of a research testbed at the Alabama A&M University's Winfred Thomas Agricultural Research Station, near Hazel Green, Alabama. The testbed consists of four 50 x 60 m plots, instrumental with state-of-the-art hydrologic and microwave remote sensing devices to measure surface and subsurface soil moisture. The scientific objectives focused on defining the soil depth, emitting and reflecting energy at various microwave wavelengths, characterizing temporal and spatial variability of surface moisture, and measuring soil moisture at different frequencies.

The remote sensing measurements from the field experiments were supported by soil profile instruments which measured temperature fluxes, current soil moisture, gravimetric soil moisture measurements, and a detailed soil and vegetation characterization within the testbed. This field experiment will be repeated during August 1997.

Sensor Development (SD)

These scientists are investigating the feasibility of developing a portable soil moisture measuring device that is inexpensive, accurate to within $\pm 1\%$, and easy to use. Three approaches are being followed: non-traditional materials; infrared reflectance and Raman scattering; and optical reflectance techniques. Devices from each approach have been fabricated and tested in the laboratory and will be deployed under field conditions during the Huntsville '97 field experiments.

Evolutionary Computing (EC)

This research area focuses on the creation of algorithms that will enable one to predict both the forward and inverse behavior of the soil moisture problem. Using simulated data which contained variables for elevation, soil type, evapotranspiration rates, rainfall, transport, and noise, an associative memory was developed to predict moisture samples. This model is better known as the Fast Analog Associative Memory (FAAM). From the data generated, a leveling of the measure was apparent. The absolute level was slightly higher for cases with noise, but still tended to level, indicating that this particular problem is solvable. This method will be tested on real-world data from the Huntsville '96 and '97 field experiments.

Morehouse School of Medicine

Space Medicine and Life Sciences Research Center (SMLSRC).

The SMLSRC has as its objectives to 1) develop the core infrastructure for space medicine and life sciences research; 2) develop the research capabilities and experiences in the area of space medicine and life sciences by existing faculty; 3) support the SMLSRC research efforts through the recruitment of postdoctoral research associates and additional faculty; 4) develop a student research training component and advanced graduate courses in space medicine and life sciences; and 5) develop collaborative relations with NASA, other universities and private industry. The long-term goals for the proposed SMLSRC are: 1) develop the Center to produce exceptionally trained minority and women scientists

in space medicine and gravitational biology research; 2) provide a critical mass of faculty and other personnel through the core program of the center to strengthen.

The SMLSRC consists of three parts: i) The Administrative Office which will direct all SMLSRC programs and will facilitate the development of the student research training and graduate program components; ii) The Core Program which will develop the core infrastructure for gravitational biology research, provide an additional faculty, and postdoctoral research associates, and iii) The SMLSRC Research Program which will provide support for the development of ground-based research to assess the mechanisms underlying the cardiovascular, musculoskeletal and neuronal effects of microgravity. These research groups will interact through collaborative research and planned activities with other MSM units. The proposed multidisciplinary studies will be carried out using the following simulated-microgravity models: the low-shear horizontally rotating bioreactor for cellular studies; the head-down tilt hindlimb suspended rat model, and the acute/chronic bed-rest head-down tilt human model. The three research groups will use one or more of these models and thus obtain data that can be integrated and will provide a more precise understanding of the physiological responses to microgravity. These different components are complementary and will result in the SMLSRC developing into a multifaceted research center. The training component of the SMLSRC will increase the number of minority students exposed to the area of space medicine and life sciences research. The benefit to NASA is the immediate increase in minority postdoctoral level researchers involved in this important area. As the SMLSRC develops and faculty research expertise becomes established, it is anticipated that increased collaborative relationships and non-NASA support will occur.

Prairie View A&M University
Center for Applied Radiation Research (CARR)

CARR was established to address missions and critical technologies of NASA. The mission of CARR is based on four components: research, human resource development, service, and commercialization and technology transfer. CARR conducts research in three technical areas: Space Environment Simulation; Radiation Effects on Electronic & Photonic Systems; and Radiation Effects on Bio-Systems. CARR covers a range of topics for research, while keeping to the single unifying theme of radiation effects. CARR is unique in that it addresses issues from the microscopic level, truly “systems level” materials, complex integrated circuit systems, physiological studies at the cellular level, and the human reproductive and immune systems.

This research area focuses on the creation of algorithms that will enable one to predict both the forward and inverse behavior of the soil moisture problem. Using simulated data which contained variables for elevation, soil type, evapotranspiration rates, rainfall, transport, and noise, an associative memory was developed to predict moisture samples. This model is better known as the Fast Analog Associative Memory (FAAM). From the data generated, a leveling of the measure was apparent. The absolute level was slightly higher for cases with noise, but still tended to level, indicating that this particular problem is solvable. This method will be tested on real-world data from the Huntsville ‘96 and ‘97 field experiments.

Remote Sensing/GIS (RS/GIS)

This research area focus on the use of basic and advanced automated image processing techniques to assess surface vegetation, soil, and water conditions of the Earth's surface. Current research involves an assessment of vegetation characteristics associated with land cover type as a component of the hydrology of the Middle Coosa River in northeastern Alabama. Quantitative data has been collected at 85 sites throughout three sub-watersheds of the study area. Vegetation data were summarized by four characteristics: Relative abundance; relative dominance; relative frequency; and importance value. These indices will be compared with vegetation classifications obtained from TM imagery captured during the summer of 1995.

Educational Outreach (EO)

We have established an educational outreach component of HSCaRS to address the need for increasing the number of underrepresented minorities who are U. S. citizens with advanced degrees in NASA-related fields. We have initiated an undergraduate Summer Enrichment Program (SEP) which began the summer of 1996. The program is designed to provide undergraduate students in NASA-related fields an opportunity to participate in meaningful research tasks that contribute to NASA and HSCaRS research mission.

RESEARCH ACCOMPLISHMENTS

Process and Radiation Induced Defects

We have continued to improve our measurement capabilities which will allow a better understanding of defects at the interface between silicon and silicon dioxide. The quality and integrity of this interface governs the performance of most advanced integrated circuits, including those used in space applications. The space radiation environment can damage this interface and alter the point at which an electronic device becomes active in a particular application. Recent CARR findings have lead to a better understanding of two major types of radiation induced interface defects. Acting as CARR subcontractors, research collaborators at major universities have confirmed our results by independent measurement techniques.

Single Event Effects

High energy particle accelerators are used to simulate cosmic rays which cause soft (recoverable) errors in memory circuits called "single event upsets" (SEU). CARR experiments have confirmed theoretical predictions which bring into question the usual assumptions on the angular dependence related to how much energy a cosmic ray deposits in the materials making up a unit of computer memory. These theoretical and experimental results could influence tests for single event effects.

Circuit Innovations

A switched capacitor, restively-hardened memory circuit has been designed and is being fabricated to reduce to practice. Circuit simulations indicate that the device is an attractive alternative to standard resistively-hardened memory circuits. This circuit is currently under patent review by the Prairie View A&M Research Foundation.

Emerging Technologies

CARR has embarked on projects in new materials and quantum devices that have the potential for revolutionizing space technology. This work has attracted mainstream support and major university research collaborators. For example, the surface of the novel wide bandgap semiconductor ilmenite (a common mineral on the moon) has been studied with scanning probe microscopy and x-ray photoelectron spectroscopy to facilitate electrical characterization of the materials. CARR is also interested in the radiation effects of future generations of quantum electronic devices that may be used in space. This work represents an excursion into a new field of scientific inquiry.

Life Science

CARR work in the life sciences has identified a common endpoint that will help establish a “fingerprint” of radiation-involved damage to cells related to reproduction in culture.

Tennessee State University

Center for Automated Space Science (CASS).

The CASS is to achieve a broad-based aerospace research capability which will: foster new science and technology concepts for autonomous space systems; expand the nation’s base for aerospace research and development; develop methods for increased participation by faculty and students at TSU and its partners at Western Kentucky University and South Carolina State University; and increase the number of underrepresented minorities who are US citizens with advanced degrees in NASA-related fields.

RESEARCH ACCOMPLISHMENTS

During its first year, CASS researchers produced 35 publications which communicated their findings to the scientific community. Research highlights for year one are presented below.

Automated Astronomy Group

TSU began construction of its 2-m automatic spectroscopic telescope (AST) as the flagship instrument of a completely automated observatory. CASS astronomers located a site for the AST at Washington Camp, Arizona, which is owned by Fairborn Observatory, the on-site manager of the TSU automatic photometric telescopes (APTs). TSU researchers decided to build the telescope and dedicated spectrograph in Tennessee. The basic properties of both the telescope and spectrograph were determined, a 2-m primary mirror was purchased, and a contract was awarded for the secondary mirror.

After a rather lengthy period of debugging, the new TSU 32-in. APT began making routine, high-precision observations of solar duplicate stars in the spring of 1996. Our four APTs collected 32,352 group observations of semi-regular pulsars, chromospherically active (CA) stars, lower-main-sequence stars, and solar duplicates. For the first time, one of our APTs was successfully controlled via the Internet in near real-time by a prototype artificial-intelligence scheduler running on a remote computer at the NASA Ames Research Center. An analysis of the 30-in. and 32-in. APT observations of solar-type stars demonstrated a precision of roughly 0.0002 magnitude in the seasonal means, sufficient to track solar luminosity cycles. The results of a major automated search with

the 16-in. APT for low-amplitude photometric variability in new CA stars were published (AJ, 110, 2926, 1995). Forty-one new variable CA stars were discovered, and their properties were discussed in this paper. Important new insights into the photometric behavior of CA stars were also published (ApJ, 462, 888, 1996). A paper was submitted (ApJ, 474, 503, 1997) on the properties of several old, solar-type stars recently discovered to exhibit radial-velocity variations that implied the existence of planetary mass companions. Our observations proved crucial to confirming the existence of these new planets by eliminating alternative explanations to the radial-velocity variations (e.g. pulsations, starspots, or convective motions). A careful search for transits of the companion to 51 Pegasi was not successful, but nevertheless demonstrated a precision sufficient to discover transits of Earth-size planets around old, solar-type stars under favorable circumstances.

Advanced Control Systems Group

Researchers have developed a new approach to detect structural damage to flexible structures by measuring the changes of transfer function parameters. While our computer simulation has yielded promising results for simple models, we are currently expanding this approach to more complex cases.

A portion of the TSU MATLAB Robust Control Toolbox has been placed in the public domain to test its demand as well as its design and analysis of real world problems.

Clark Atlanta University

High Performance Polymers and Ceramics Research Center (HIPAC)

HIPAC has developed the infrastructure and research focus necessary to carry out cutting-edge research and development in high-performance polymers and composites, in order to address problems important to NASA's Aeronautics Enterprise. The Center is focused on fundamental and applied research and the attendant human resources development in Chemistry, Physics, Materials Science, and Engineering.

RESEARCH ACCOMPLISHMENTS

Synthesis, Characterization, Properties, and Processing of Polyimides

Polyimides are advanced materials that have good high-temperature stability, excellent dimensional stability, and excellent mechanical, electrical, and chemical resistance properties. They can be molded for applications including those in jet engine parts, glass fiber-reinforced blocks, and printed wiring boards, and can also be produced as films for use in electric motors, flat flexible cable, and magnetic wire insulation. Additionally, they can be applied as coatings on semiconductor devices and electrical components. However, the use of polyimides in Aeronautics programs is limited by the requirements of extreme processing conditions caused by very high glass transition temperatures and high melt viscosities. In order to improve upon the processability of polyimides and to extend their use in composite applications, HiPPAC investigators have synthesized and incorporated a series of new bisimide processing additives into Langley Research Center (LaRC) TPI and Ultem[®] polyimides. These processing additives significantly lower the glass transition temperatures, flow temperatures, and melt viscosities - thus allowing for

easier processing - while producing only minimal effects on the chemical resistance and mechanical properties of the polyimides.

Preparation and Characterization of Non-Linear Optical (NLO) and Photorefractive Polymers

Polyimides which exhibit NLO behavior have applications in fast electro-optical switches and modulators for optical communication, laser frequency conversion, and optical switches for ultra-fast computation. Polyimide-based photorefractive materials are the principal candidates for applications including high-density optical data storage and image processing. We have covalently incorporated 2-(4'-nitrophenyl)-4,5-bis(4'-methoxyphenyl)-imidazole, a robust NLO chromophore, into polystyrene-co-methyl methacrylate (SMMA) and 6-FDA-4,4'-diamino-3,3'-dihydroxybiphenyl polyimides, which produces new polymers that exhibit good electro-optical behavior. Tricyanovinyl-substituted triarylamine have been prepared as new dual-functional photorefractive materials, serving as both the NLO chromophores and as sites for charge generation and transport.

Smart Material Systems

Smart Material Systems is an emerging technology area aimed toward the development of material systems and structures that can rearrange themselves to their optimum functional capabilities, or to adapt to external stimuli by using inherent or integral functional elements such as sensors, actuators, and controllers.

We have surveyed and evaluated new coupled-field finite elements available in commercial finite element codes. The effect of temperature sensitivity of piezoelectric actuators on high-performance piezoelectric composites has been studied by finite element analysis. It was found that piezo materials are sensitive to temperature variation, and that this can noticeably affect the actuation response of the composites in which they are embedded. An experimental set-up for characterizing the converse piezoelectric effects of piezopolymer films has been designed and fabricated.

We have also demonstrated experimentally that a piezoceramic micro-actuator bonded in the vicinity of a bolted-joint in a structure can be used to detect stiffness degradation of the joint. The application of these integrated microsensors/microactuators provides an opportunity to monitor the integrity of large structures, including trussed systems such as bridges, dome roofs, antennae, and the space station, by continuous monitoring of the dynamic response signatures of intelligently induced and electronically captured oscillations.

Fabrication and Mechanical Characterization of Polymer-Based Composites

Researchers are also working on the design, fabrication, processing, durability, testing, and modeling for life-time prediction and aging of Polymer Matrix Composites (PMCs) and Hybrid Metal Composite Laminates (HMCLs). We have focused on fundamental materials issues at the microscale, and on interfaces, analytical modeling, thermo-mechanical fatigue testing and evaluation, and constitutive and damage modeling. The use of PMCs and HMCLs in place of metals results in significant weight savings, leading to

improved performance and fuel economy, as well as increased aircraft range or passenger/payload capacity.

The HiPPAC Center has developed the capability to prepare hybrid metal composite laminates up to 12 x 12 inches. Thermo-mechanical Analysis/Stress Strain (TMA) has been used to measure linear and volumetric changes in the dimensions of small “lap joints” of the laminates as a function of applied force, time, and temperature. The storage modulus, E' (a measure of the stiffness or rigidity of the laminates) and the loss modulus, E'' (a measure of the degree to which the laminates dissipate mechanical energy by converting it to heat through molecular motion) have been measured. 2-dimensional infrared mapping has been utilized to investigate the mode of delamination of the polymer from the metal substrate in failed joints.

Florida A&M University

Center for Nonlinear and Nonequilibrium Aeroscience (CeNNA)

CENNA conducts research on the dynamics and the aero-thermo-chemistry of gases and materials relevant to the NASA Aeronautics Enterprise. The research is aimed at new insights into and new diagnostic procedures for turbulence and molecular relaxation processes in: compressible neutral and ionized gases; aeroacoustics; propulsion dynamics; combustion; and heterogeneous nucleation, as well as programs of research on the characterization of stressed materials, film deposition processes, and the fundamental physics of electron and atomic collisions in the re-entry regime.

RESEARCH ACCOMPLISHMENTS

Turbulence Modification of Nonequilibrium Condensation Processes

Heterogeneous nucleation and the subsequent droplet and crystal growth play a critical role in the contribution from polar stratospheric clouds (PSC) and vapor trails to atmospheric environmental concerns, and also in the development of ice crystals on environmentally exposed aerofoils. Yet the best growth rate theories are essentially ad hoc and/or empirical, with very weak experimental confirmation of underlying physical principles. We have begun to test and extend these theories. We have found a new clear dependence of droplet size on the strength of turbulence. Furthermore, when the rate of droplet growth is measured by observing the change in droplet size at two locations, we find that the rate of change of droplet size is also dependent on the Reynolds number.

Direct Estimation Velocimetry for Measurements of Reynolds Stresses and Vorticity

A rank ordering of modeling approximation techniques for strong turbulence requires a dedicated relationship between theoretical approaches and experimental facilities. We have provided such a testing ground, and have confirmed the applicability of our new diagnostic procedure, Direct Estimation Velocimetry (DEV), to turbulent compressible flow. Using DEV, we have performed simultaneous measurements of density, vorticity, and all components of velocity from laser-induced fluorescence at a data rate in excess of 2 MHz in a turbulent supersonic free shear layer. Our data shows clear evidence of vanishing triple correlations. The averages of triple correlation terms $\langle u'u'v' \rangle$ and $\langle u'u'w' \rangle$ in consecutive time intervals are shown in Fig. 1; specifically, the average value is

0.029±0.04, which is statistically consistent with the prediction of a value of zero for the triple correlation. These measurements offer a first confirmation of the validity of predictions in the theoretical approach, which suggests that macroscopic turbulent transport may be determined by microscopic molecular phenomena.

Role of Streamwise Vorticity on Mixing and Noise Characteristics of Supersonic Jets

Recent research has suggested that the addition of streamwise vorticity, or swirling flow, enhances the mixing of hot jet exhaust gases with the colder ambient air, resulting in a reduced infrared (IR) signature for fighter aircraft, and is also expected to significantly reduce the side-line noise from supersonic jet engines. To this end, a unique diamond-shaped, converging-diverging (c-d), Mach 2 nozzle was designed for a detailed investigation of the effect of significant streamwise vorticity on the acoustic and IR characteristics of supersonic jets. The diamond-shaped nozzle geometry was chosen because it was expected that the sharp corners of the diamond nozzle would lead to the creation of significant streamwise vorticity and subsequently to a modification of the mixing and acoustic properties of the jet. In addition, the high nozzle area-to-perimeter ratio of the diamond nozzle leads to minimal thrust losses. These factors make the diamond nozzle an attractive choice for further exploration.

We find that the presence of distinct ‘rippled’ structures along the jet periphery is clearly visible in the laser light sheet images of the jet cross-sectional plane. These images, together with the results of pressure surveys conducted in the jet periphery, provide convincing evidence of the presence of significant streamwise vorticity in the periphery of the diamond-shaped jet. This increased the local thickness of the shear layer, while only moderately influencing the jet diffusion rate. However, the effect of vorticity on the far-field noise was fairly significant; for a hot jet, a 5dB reduction in jet side-line noise was measured when compared to the noise properties of conventional round jets

Thermally Induced Stress Measurement and Load Relaxation

It has been the focus of this project to characterize advanced materials for all ranges of temperatures and strain rates and to arrive at unified constitutive relations. A new technique of measuring real-time whole field displacement gradient with a resolution of 0.5μm has been developed. The measurements take place in the heating chamber of an Environmental Scanning Electron Microscope. This technique has been applied to the matrix of a Ti-24Al-11Nb composite reinforced with SiC fibers.

The relaxation data for a wide strain-rate range have been measured and analyzed. Upon the completion of a relaxation test, the measured stress is allowed to reduce by a substantial amount. In this set of experiments, the specimen was loaded to the same superplastic strain-rate until the next strain level was obtained. We find that the stress increases systematically during both strain-rate change tests and load relaxation experiments. A constant strain-rate test curve is obtained which represents the true stress strain state for the imposed strain-rate ($5 \times 10^{-4} \text{sec}^{-1}$). This procedure allows us to determine the set of all steady state stress values for a particular imposed strain-rate at different strain values.

Hampton University
Research Center for Optical Physics (RCOP)

RCOP promotes world-class leadership in selected areas of optical sciences and technologies, and to develop under-utilized human resources to meet the nation's science and engineering manpower needs in the twenty-first century. The vision of RCOP is to establish Hampton University as a premier institution for optical scientific advancement and education in the mid-Atlantic United States. There are three areas of research that form the core of the RCOP's strategic focus:

- Atmospheric Sciences and Optical Remote Sensing Technology
- Optical Materials (including laser, nonlinear optical, and smart materials development)
- Non-Intrusive Diagnostics

RESEARCH ACCOMPLISHMENTS

During the past year, RCOP researchers have developed a variety of new technologies and have made a number of significant scientific discoveries. In the area of Atmospheric Sciences and Remote Sensing, RCOP researchers have developed: new laser light sources that are being used to study ozone molecules in the upper atmosphere; a new tunable infrared laser for use in the measurement of greenhouse gasses for the study of global warming; and new laser technology used to assist NASA scientists in their study of aircraft wake vortices, a major factor in airline safety.

In the area of Optical Materials, RCOP has: developed a new patented method of calibrating fiber-optic sensors for use in monitoring structures such as bridges or airplane wing surfaces; made discoveries about the physical properties of new holographic data storage materials that have the potential to dramatically increase data storage capacity above that of CD ROM's; successfully fabricated new organic thin films for use as low-current LEDs, thresholdless laser devices, and photonic band gap materials; and developed new technology for the testing of mid-infrared laser materials for use in eye-safe lasers for remote sensing.

In the area of Non-Intrusive Spectroscopy, RCOP has: developed new technology to detail the flow analysis of the High-speed Flow Generator (HFG) at NASA-LaRC for use in aerodynamic measurements; developed new techniques to measure the flow velocity at the nozzle exit of the Solar Thermal-Electric Propulsion (STEP) systems for use in low- to high-orbital transfer vehicles; and developed a new, very high sensitivity, focusing Schlieren system for a fast-flow visualization of low-density flow-fields.

The Center has also established numerous research and educational collaborations with private industries, NASA and other government agencies, and universities. Some of these include: Brimrose Corporation of America; Deltronic Crystal Industries, Inc.; Spire Corporation; Hughes Research Laboratories; Northrop-Grumman; NASA LaRC; NASA Lewis; Clark Atlanta University; the University of Virginia; Florida A&M University; the University of Rochester; University of Hamburg; Fisk University; Norfolk State University; the University of Florida; California State University, Sacramento; Virginia

Polytechnic Institute; Virginia State University; and the AF Loffe Physicotechnical Institute of the Academy of Sciences in St. Petersburg, Russia.

This year the Center has completed development of six state-of-the-art research laboratories:

- The Optical Remote Sensing Technology Laboratory is developing: lasers for lidar remote sensing of the atmosphere (especially those of significant value to NASA); field measurements with lidar systems; interpretation of lidar data in conjunction with other atmospheric data in order to understand atmospheric chemistry and physics; and laser diagnostic techniques for other applications.
- The Ultra-Fast Laser Spectroscopy Laboratory has developed a state-of-the-art wave mixing spectroscopy laboratory for the study of nonlinear properties of new materials, such as single crystal oxides, polymers, organic tin films, and multiple quantum well devices.
- The Organic Thin Film Laboratory has developed the technology for fabrication of organic thin film devices for use as low-current LEDs, thresholdless laser devices, and photonic band gap materials.
- The Fiber-Optic Sensors and Smart Materials Laboratory is fabricating discrete stress, strain, temperature, and acoustic fiber-optic sensors along with their readout interfaces for NASA- oriented uses. Also under development in this lab are high definition distributed Bragg grating fiber-optic sensors, and systems which can address particular needs of NASA's *Mission to Planet Earth*.

The Laser Materials Development Laboratory and the Non-Intrusive Diagnostics Laboratory have established a high-resolution spectroscopy facility that allows complete visualization of aerodynamic flows; developed an advanced global flow visualization system; and developed new optical diagnostic techniques to allow detailed analysis of the flows for validating models of physical and chemical processes in aerothermodynamics and propulsion research.

Fisk University

Center for Photonic Materials and Devices

Center for Photonic Materials and Devices aims at performing research and developing technologies relevant to NASA's mission, focusing in the field of photonics. Research in photonics has made possible the development of new technologies that have produced revolutionary changes in communications, computing, robotics, medicine, environmental control, and many industrial processes. Additionally, the potential reputation of the Center will attract an increased number of traditionally under-represented minority students, both graduate and undergraduate, and will motivate them to pursue careers relevant to the NASA mission.

RESEARCH ACCOMPLISHMENTS

The NASA/Fisk Center has focused its research on one of the most promising branches of photonics, that which produces new materials or improves the production of known materials, which are the initial stage of the development of most new advanced technologies.

One research group uses recently developed nano-technology methods to produce new materials which contain inclusions of single atoms or clusters of new atoms. These materials show surprising new properties, such as being able to change the color of light beams (which may increase the capacity of computer memories and compact disks), and to switch light beams on and off in extremely short times. This may lead to the development of optical computers, which are potentially much faster and more efficient than electronic ones. Recently, this group has contributed to resolving a long-standing controversy on how the clusters change their properties as they grow from a few atoms to their final size (published in *Physical Review*, 1996). The research of this group drew attention which resulted in 5 invited talks at National Laboratories and Universities, and drew new collaborations and financial support from two NASA Installations: NASA Lewis Research Center (Photovoltaics); and NASA Marshall Space Flight Center (Polymer Division).

Another group studies new crystalline materials for the detection of light, x-rays, and gamma-rays. This research includes purifying the materials, growing the crystals, determining their physical and chemical properties, and making and testing detectors. These solid-state detectors have a wide range of applications in industrial production control, military equipment, satellite studies of space and the Earth, and medical diagnostic equipment. This group was awarded a patent for a non-contact device to measure the temperature of crystals growing in a sealed glass ampoule, allowing for a better choice of growth conditions. Another patent is pending for the measurement of other growth parameters. Also, this group has delivered to Marshall Space Flight Center an original instrument for the ultra-purification of chemicals used in crystal growth. A collaboration with Goddard Space Flight Center was started, leading to the testing of laboratory-built x-ray and gamma-ray detectors in Goddard balloon flights.

A third group is working with glasses and other optical materials, which could be used to make new laser sources, improve information storage technology, and develop optical sensors. Glasses have the advantage of easily being formed into whatever shape is required, and in particular can be drawn into very thin optical fibers. Some of the glasses being studied at Fisk can be used to convert infrared light into visible light, and others are photosensitive glasses which can be used to make fiber-optic strain, vibration, and temperature sensors. This group has produced a new glass (Erbium doped-lead-tellurium-germanate) which efficiently transforms invisible infrared to green light (usable for better disk memories), and a new crystal (Vanadium doped-cadmium-sulfur-selenide), which has the optical properties required for making compact reversible holographic memories with greater capacity than anything presently available.

Finally, a fourth group possesses the most modern equipment for studying the physical structure and chemical composition of solid surfaces. This enables measurements to be

made up to the limit of locating single atoms, and to be made in environments from normal atmospheres to ultra-high vacuum. These techniques provide important information for the improvement of the fabrication processes involving solid surfaces, including the extra-thin multi-layers which constitute integrated circuits, and are also useful in the determination of damage suffered by equipment components due to their use, exposure to the environment, etc.

North Carolina A&T State University
Center for Aerospace Research

The Center for Aerospace Research aims at performing research and developing technologies relevant to NASA's mission, focusing in the field of photonics. Research in photonics has made possible the development of new technologies that have produced revolutionary changes in communications, computing, robotics, medicine, environmental control, and many industrial processes. Additionally, the potential reputation of the Center will attract an increased number of traditionally under-represented minority students, both graduate and undergraduate, and will motivate them to pursue careers relevant to the NASA mission.

RESEARCH ACCOMPLISHMENTS

The NASA/Fisk Center has focused its research on one of the most promising branches of photonics, that which produces new materials or improves the production of known materials, which are the initial stage of the development of most new advanced technologies.

One research group uses recently developed nano-technology methods to produce new materials which contain inclusions of single atoms or clusters of new atoms. These materials show surprising new properties, such as being able to change the color of light beams (which may increase the capacity of computer memories and compact disks), and to switch light beams on and off in extremely short times. This may lead to the development of optical computers, which are potentially much faster and more efficient than electronic ones. Recently, this group has contributed to resolving a long-standing controversy on how the clusters change their properties as they grow from a few atoms to their final size (published in *Physical Review*, 1996). The research of this group drew attention which resulted in 5 invited talks at National Laboratories and Universities, and drew new collaborations and financial support from two NASA Installations: NASA Lewis Research Center (Photovoltaics); and NASA Marshall Space Flight Center (Polymer Division).

Another group studies new crystalline materials for the detection of light, x-rays, and gamma-rays. This research includes purifying the materials, growing the crystals, determining their physical and chemical properties, and making and testing detectors. These solid-state detectors have a wide range of applications in industrial production control, military equipment, satellite studies of space and the Earth, and medical diagnostic equipment. This group was awarded a patent for a non-contact device to measure the temperature of crystals growing in a sealed glass ampoule, allowing for a better choice of

growth conditions. Another patent is pending for the measurement of other growth parameters. Also, this group has delivered to Marshall Space Flight Center an original instrument for the ultra-purification of chemicals used in crystal growth. A collaboration with Goddard Space Flight Center was started, leading to the testing of laboratory-built x-ray and gamma-ray detectors in Goddard balloon flights.

A third group is working with glasses and other optical materials, which could be used to make new laser sources, improve information storage technology, and develop optical sensors. Glasses have the advantage of easily being formed into whatever shape is required, and in particular can be drawn into very thin optical fibers. Some of the glasses being studied at Fisk can be used to convert infrared light into visible light, and others are photosensitive glasses which can be used to make fiber-optic strain, vibration, and temperature sensors. This group has produced a new glass (Erbium doped-lead-tellurium-germanate) which efficiently transforms invisible infrared to green light (usable for better disk memories), and a new crystal (Vanadium doped-cadmium-sulfur-selenide), which has the optical properties required for making compact reversible holographic memories with greater capacity than anything presently available.

Finally, a fourth group possesses the most modern equipment for studying the physical structure and chemical composition of solid surfaces. This enables measurements to be made up to the limit of locating single atoms, and to be made in environments from normal atmospheres to ultra-high vacuum. These techniques provide important information for the improvement of the fabrication processes involving solid surfaces, including the extra-thin multi-layers which constitute integrated circuits, and are also useful in the determination of damage suffered by equipment components due to their use, exposure to the environment, etc.

Howard University

Center for the Study of Terrestrial and Extraterrestrial Atmospheres

Center for the Study of Terrestrial and Extraterrestrial Atmospheres establishes at Howard University a self-supporting, world class facility for the study of terrestrial and extraterrestrial atmospheres, with special emphasis on the training of underrepresented minorities in Aerospace-based Sciences and Engineering. To this end, CSTEa has implemented the Howard University Program in Atmospheric Science (HUPAS), a new graduate degree program in Atmospheric Sciences. This program offers courses in Atmospheric Chemistry, Physical Meteorology, Geophysical Fluid Dynamics, Air Pollution, and a variety of other related topics. There is also a "Current Topics in Atmospheric Sciences Seminar," which features weekly speakers from Goddard Space Flight Center's Laboratory for Atmospheres.

RESEARCH ACCOMPLISHMENTS

CSTEa researchers and students continue to be involved in the acquisition and analysis of data from instruments aboard NASA's EOS satellites. ATMOS/ATLAS I measurements of thermospheric and mesospheric NO have been analyzed, in order to understand NO production and its sensitivity to solar variations in the upper atmosphere. The results of

these studies indicated that the discrepancies in the measurements worsen with photochemical models at low latitudes.

In another study, a combination of satellite data from the Special Sensor Microwave/Imager (SSM/I) and Mesoscale Model Simulation have been used to explain the Southern Hemisphere's topical ozone maximum. The results of these studies indicate a significant role of lightning and vertical transport associated with deep convective systems in the transport of pollutants from biomass fires in continental Africa to the South Atlantic.

Experimental and theoretical studies of the chemistry in the atmosphere of Titan have also been performed. Laboratory techniques involving laser spectroscopy and mass spectral analysis have been used to measure photoabsorption cross-sections and kinetics of cyanoacetylenes and their reactions. Quantum chemical calculations have been used to explore the structures and energetics of these reactions. Through these studies, we have gained a deeper understanding of the photo-chemistry and evolution of this primitive atmosphere.

One of the major efforts at CSTEa involves the design and development of a Quartz Crystal Microbalance (QCM) instrument and chemical coatings which are sensitive to select trace gases. This instrument has the capability of simultaneously measuring both minute aerosol particles and low-concentration gases in various regions of the atmosphere. The QCM instrument uses the change in the frequency of a vibrating quartz crystal to measure the mass of either particulates or gases that have attached to its surface. Thin chemical films are being developed with specific sensitivity to various chemical compounds such as ammonia, ozone, sulfur dioxide, organo-phosphorous compounds, nitrogen oxides, nitric acid, and even the vapors of explosives. Measurement of the concentrations and spatial distributions of many of these compounds are important for assessing the environmental impacts of aircraft and industrial emissions. The development of the QCM instrument has allowed detection sensitivity down to 1 ng/cm^3 .

In another part of the research at CSTEa, we are developing microbalances with silicon carbide and other wide-bandgap semiconductor materials. These materials, because of their unique physical properties, should increase the sensitivity of these detectors to at least 0.1 ng/cm^3 . The development of the QCM instrument supports NASA's efforts to understand the complex chemistry of the lower atmosphere by providing a simple and acoustic measurement method.

Tuskegee University

Center for Food Production, Processing, and Waste Management for Controlled Ecological Life Support Systems

Center for Food Production, Processing, and Waste Management for Controlled Ecological Life Support Systems provides sweetpotato and peanut information and technologies and student training applicable to bio-regenerative food production systems for life support on long-term manned space missions. The research responsibilities

required to achieve this goal have been divided among several research units, five of which are highlighted below. Student trainees are an integral part of the research.

RESEARCH ACCOMPLISHMENTS

Our Growing Systems and Environmental Factors Unit has been concentrating on determining the best systems and environmental conditions for growing sweetpotatoes and peanuts hydroponically for space missions. During 1996, Kennedy Space Center (KSC) suggested that we compare the growth of sweetpotatoes using their fan-shaped growing trays and protocol with the rectangular channels and protocol used at Tuskegee University (TU). Preliminary results indicated that production within the KSC system results in a preponderance of sweetpotato foliage over storage roots, with the opposite occurring using the TU system. The nutrient solution compositions appear causative. While leaves are nutritious and edible, only very limited amounts can be accommodated in space. Other studies were carried out with peanuts in order to determine the best conditions for their growth. When peanuts were grown under conditions of elevated CO₂ - a condition of closed systems in space - it was found that the growth of seeds, pods, leaves, and roots in three peanut cultivars was enhanced by increasing CO₂ levels from 400 (ambient) to 700 mmol mol⁻¹.

Our Germplasm Development Research Unit aims to improve sweetpotato and peanut crops through biotechnology. In 1996, this Unit confirmed that some of the transgenic sweetpotato lines they developed showed protein increases of three- to five-fold over the control.

Our Nutrition and Food Processing Research Unit is working on the processing of the edible parts of peanuts and sweetpotatoes into a variety of nutritious and palatable foods. Much has been done with sweetpotato products in the past, and last year one company expressed interest in commercializing our sweetpotato beverage. This resulted from a 1996 summer fellowship awarded to our product development specialist by the US Department of Agriculture, which focused on the product commercialization process. During 1996, this Unit concentrated on developing new peanut products and recipes. The goal here is to provide tasty, nutritional, and varied foods for future space workers, with commercial spin-offs a secondary benefit.

Our Waste Management and Recycling Unit showed in 1996 that nutrients in the inedible parts of sweetpotatoes can be recovered and recycled in a replenishment protocol for further sweetpotato production.

Finally, our Plant Modeling Unit collects data and recommends experiments for the purpose of retrieving additional needed information on growing sweetpotatoes and peanuts in controlled environments. A hypothesis which this Unit developed in 1996 relates starch storage in sweetpotatoes to storage root initiation. If this hypothesis proves to be true - and experiments are underway to test it - it will be important not only to food production in space, but also to sweetpotato producers on Earth, particularly in areas of expected food shortages.

FACULTY AWARDS FOR RESEARCH (FAR)

FAR is a NASA principal investigation program that began to include faculty from HBCU's in FY 1994. The goal of the FAR program is to achieve NASA's mission while increasing cultural diversity in the NASA-sponsored research community. The FAR program identifies outstanding and promising Principal Investigators (PI) at minority institutions, and provides them with research support to provide opportunities to demonstrate creativity, productivity, and competitiveness in NASA's mainstream research process. During FY 1996, NASA awarded nine continuing grants and 16 new grants to PI's at HBCU's. An additional objective of the FAR program is to increase the number of underrepresented minorities and students with disabilities receiving mathematics, science, engineering, and technology research experience and entering careers in NASA-related fields. Forty-five of the 83 students (54%) participated at the bachelors degree level; 28/83 (34%) participated at the masters degree level; and 10/83 (12%) participated at the doctoral degree level. Fifty seven percent of the participating students were members of an underrepresented ethnic minority group.

Twenty eight student participants obtained degrees during the reporting year: 14 bachelors degrees; 12 masters degrees; and 2 doctoral degrees. Sixty eight percent of the graduates were members of an underrepresented ethnic minority group. Thirteen of the graduates were employed in NASA-related fields: 5 bachelors degree graduates and 8 masters degree graduates. Seven of the fourteen bachelors degree graduates (50%) planned to continue on for graduate degrees, while 5 of the 12 masters degree recipients planned pursue a doctoral degree. In total, 86% of the students receiving degrees remained in the pipeline by continuing for the next degree, or by accepting employment in a NASA-related field.

A brief reports from some of the projects funded during FY 1996 follows:

Clark Atlanta University -

Chemically Derived Dense Alumina-Zirconia Composites for Improved Mechanical and Wear Erosion Properties:

The development of new materials with improved properties such as strength, toughness, and wear resistance for advanced structural applications (e.g., engine components), will be crucial in meeting emerging high-technology aerospace applications. Zirconia-toughened alumina (ZTA) has the potential improvement in toughness and strength when compared to pure alumina to meet these technology requirements. Our main accomplishment during this period has included establishing the synthesis for the preparation of high-purity ZTAs. In this research program, high-purity starting materials such as aluminum-, zirconium-, and yttrium-metal alkoxides were used to prepare ZTAs. High-purity starting materials will yield ZTA ceramics free of impurities that could migrate to grain boundaries and thereby lower strength and toughness, or may possibly lead to glass formers at the grain boundaries. Additional accomplishments have included the synthesis of ZTA precursors by using aluminum-tri-sec-butoxide, zirconium butoxide, and yttrium butoxide. We

synthesized the yttrium butoxide by performing an alcohol exchange of yttrium isopropoxide in butanol. We are now in the process of conducting calcining and sintering studies in the preparation of the final ZTA ceramic. Synthesis conditions are being varied, and their effects on the final properties of the ZTA will be established.

North Carolina A&T State University

Formal Foundations of Agents

The first objective of the proposed effort is to select and develop the appropriate formalisms for specifying agent systems and to develop a methodology for the use of these formalisms. The agent systems of interest will conform to the AGENTS model of distributed agents being developed at the Goddard Space Flight Center. Test cases for the formalisms and methodology will be taken from Goddard's intended applications of its model. The scope of the formalisms will cover agent speech acts, multi-agent reasoning and action, and agent knowledge and obligation. Formalisms to be considered include speech act theory, temporal, epistemic, and deontic logics, formal ontology, and nonmonotonic logics. A major output will be a user's document presenting the formalisms and methodology.

Subsequent objectives will extend our formal approach to Goddard's agent communication language and features of agent systems useful to Goddard. Semantics will be provided for certain language constructs, and algorithms, inference methods, or protocols will be developed for select system features. A general object to be pursued throughout the effort is to develop African American student researches in computer science; this will be realized primarily via close research mentoring.

INSTITUTIONAL RESEARCH AWARDS (IRA))

In FY 1996 NASA will continue funding the five HBCU IRA recipients of 1995. These IRA's focus on the design of an Internet network (LAN/WAN) among HBCU's, other minority institutions and local high schools for conducting network training and NASA-related research. The recipients were Prairie View A&M University, South Carolina State University, Tennessee State University, Elizabeth City State University, and Morgan State University. Two of the recipients plans are described below:

Prairie View A&M University

Southwest Regional Network Resources and Training Site:

A NASA Southwest Regional Network Resources and Training Site has been established at Prairie View A&M University. Its goal is to create a high-speed digital network consisting of data and video channels linking a series of remote sites in the Southwestern U. S.. This network will result in creation of a virtual university for sharing of resources by all project participants. Additionally, the network will provide for enhancement of the learning experience for the traditional learning community (K-12 and college students)

served by the various partners as well as provide life-long learning opportunities for the larger adult community. Activities associated with the five-year development plan have been initiated. Specifically, full T-1 Internet connectivity has been established at several schools. A computer laboratory has been installed at Langston University.

Major training activities have been conducted for the partner schools. A training workshop held during the summer of 1996 focused upon the building of computers and computer networks. This workshop has resulted in successful projects being initiated in schools around the state. Future training efforts will include network management and development of distance learning presentation skills, as well as integration of the Internet into the curriculum.

Tennessee State University
Network Resources and Training Site:

The purpose of this project is to provide high-speed Internet connections to HBCU's, OMU's and to elementary and secondary schools with significant numbers of minority students. A second, more long-term purpose is to increase the number of minority representatives in the Math, Science, Engineering, and Technology (MSET) professions. Campus Network Committees were established at Tennessee State University (TSU) and at all of the satellite institutions. Many of these committees not only include the MSET departments, but also extend to other areas of the participating institutions. This has enhanced overall communications on the campuses related to computing, and particularly enhanced interest in the Internet and its uses in education and research.

T1 connections are also in place at Lane College, Knoxville College, and Meharry Medical College. The LAN design for the TSU Campus is in place, and is significantly implemented in the MSET departments. Enhancements were made this year, with upgrades of the connection speeds and with the addition of the server discussed above, and with new connections in forty-plus MSET faculty offices. The School of Agriculture, with help from the NRTS staff, and due to the existence of the campus backbone, has received a grant from the Department of Agriculture for computer enhancements in the Agricultural Sciences. These 29 schools are designed to enhance the use of computer technology and the Internet in the educational process of the public school classroom.

PART II - AWARDS AND NARRATIVE INFORMATION

Category 2: Program Evaluation

Training

In FY 1996, several research and education grants received extensive program assessment and evaluation by external reviewers. The Minority University Research and Education Division (MURED) contracted with a minority firm to conduct on-site evaluations of thirteen education grants. Of these thirteen grants evaluated, five(5) were Precollege Awards for Excellence in Mathematics, Science, Engineering, and Technology Awards (PACE/MSET), and eight (8) were Mathematics and Science Awards for Teacher and Curriculum Enhancement Program Awards (MASTAP).

The PACE/MSET awards are research-based outreach projects for the purpose of increasing the number, skills and knowledge of minority and disabled students in college preparatory mathematics, science and engineering fields. Funding for these grants are \$100,000 per year, for a maximum of three years. The five sites visited during FY 1996 were: Bennett College, NC; Jarvis Christian College, TX; National Hispanic University, CA; Stillman College, and; University of Texas/El Paso, TX. Four of the five institutions rated very high on a scale of zero (0) to four (4), and one institution rated average.

The MASTAP awards are institution-based support projects to increase and strengthen the skills of minority pre-service and in-service teachers in mathematics, science, engineering fields at the middle and high school levels. The funding for these grants are \$200,000 per year, for a maximum of three years. The MASTAP sites visited during FY 1996 were: Bennett College, NC; Florida International University, FL; Humacao University/University of Puerto Rico, PR; Medgar Evers College, NY; Shaw University, NC; South Carolina State University, SC; University of Puerto Rico/Mayaguez, PR, and; Xavier University, LA. All eight of the MASTAP projects scored well, with five scoring very high.

The education site visits were conducted over a period of eight (8) weeks, at a total cost of \$45,000 or \$3,400 per site.

Research and Development

Metrics for NASA HBCU Programs are being continually improved. Evaluations of individual projects within competitive programs and for unsolicited projects continue to be performed as succinct outcome metrics that are aggregable across projects and programs are being developed.

In FY 1995 and FY 1996, a program to collect key data on the URC and IRA program outcomes was piloted. In addition, an outcomes survey of all FAR award recipients was conducted. Based on the experience gained in with these instruments, a Uniform Outcomes Data collection process was developed in late FY 1996 to collect program data from Summer 1995 and Academic Year 1995-96. The objectives were to establish uniform

metrics for all NASA MUREP programs and to provide compact instruments for uniform collection of outcomes data keyed to those metrics. These metrics will reduce the collection of data to the minimal amounts possible, emphasize outcomes over processes, and be applicable to any project. They are aggregable both horizontally and longitudinally, and they allow adjustable benchmarking standards to be applied. The data was collected electronically over the World Wide Web. In the future, a single annual collection of data each July will be used to provide the information necessary for Annual MUREP Reports, required White House Reports, budget submissions and justifications, and comparative assessments of programs and projects.

Two instruments have been devised, one for basic research projects and the other for education projects. For research projects, including URC's, IRA's, and FAR, the metrics track two basic areas: student outcomes (degrees awarded and post-degree plans), and research outcomes (refereed publications, leveraged funding, patents and commercial products). Vital process information, such as numbers of faculty and students supported, and the gross categories in which funds are spent, will also be collected. This will allow formation of reports using benchmarking divisors (e.g., numbers of degrees awarded per dollar spent on students, or number of publications per faculty investigator). For education projects, the Uniform Outcomes Data shifts the emphasis from numbers and demographics of students supported to improvements in student performance. Short-term metrics track increases in test scores and increases in enrollment in mathematics and science preparatory courses for students in NASA programs. Long-term metrics track the rates at which K-12 students in NASA programs enter college and obtain advanced degrees. In addition, data on the numbers of students and institutions supported continue to be collected and reported. Outcomes data collected with these instruments is reported in the narrative for each specific HBCU program.

Electronic Management System (EMS)

The development of MURED EMS was initiated in FY 96 as an Internet-based evaluative management tool to support all the ongoing operational programs and new initiatives under the NASA Peer Review Support Contract NASW-5058. The EMS is designed with standard graphical user interface components such as, menus, icons, hyperlinked documents and electronic forms containing selection lists, icons, check boxes and radio buttons. The EMS electronic forms are designed for specific program objectives and focusing on activities such as surveys, proposal submission, proposal evaluation, data analysis, grants management and generation of adhoc or customized reports. These electronic forms are the primary user interface for data manipulation and for running customized applications based on specific program requirements. The MURED EMS is platform independent and at present supports PC, MAC and UNIX environments. Access to the EMS is currently limited by IP address/URL to MURED staff, field installation personnel, support contractor and system development personnel.

The EMS design features which are being incorporated for the MURED programs will facilitate generation of annual plans, reports highlighting program performance metrics and will support strategic planning/budget forecasting. Multiple customized reports and adhoc report capability are in place for meeting the specific program award objectives.

The electronic surveys for generation of FY 96 Precollege Education Performance and Research & Technology reports were successfully completed. The reports are under finalization based on the data analysis and results provided by the EMS. On-line submissions of evaluations for research proposals submitted under the Faculty Awards for Research (FAR) Program are currently under way by the reviewers from NASA Field Installations.

The development costs of the MURED EMS are budgeted to be \$500,000 for FY 96 through FY 99 and the costs incurred to date for FY 96 are \$70,000.

PART II - AWARDS AND NARRATIVE INFORMATION

Category 3: Training

Continuing Activities

ALABAMA

Miles College

Miles College Learning About Plants Project	HQS/OEOP	\$63,598
---	----------	----------

Trenholm State Technical College

Science Enrichment Program	HQS/OEOP	\$179,728
----------------------------	----------	-----------

DISTRICT OF COLUMBIA

Howard University

Software Metrics and Certification of Reusable Software Components	GSFC	\$10,740
---	------	----------

Public Service Internship for Graduates of Arts and Sciences School	GSFC	\$80,800
--	------	----------

University of the District of Columbia

Saturday Academy	HQS/OEOP	\$588,790
------------------	----------	-----------

FLORIDA

Bethune Cookman College

JOVE Program	MSFC	\$1,500
--------------	------	---------

Edward Waters College

Mathematics, Science, and Technology Awards for Teacher and Curriculum Enhancement (MASTAP)	HQS/OEOP	\$100,000
---	----------	-----------

Florida A&M University

Project IMAGE: Increasing Minority Access to Graduate Engineering	HQS/OEOP	\$1,124,726
--	----------	-------------

GEORGIA

<u>Morehouse College</u> Project SPACE	HQS/OEOP	\$753,449
---	----------	-----------

<u>Morehouse School of Medicine</u> Symposium on Career Opportunities in the Biomedical and Public Health Sciences	JSC	\$50,000
--	-----	----------

<u>Spelman College</u> Women in Science and Engineering (WISE)	HQS	\$621,012
---	-----	-----------

MARYLAND

<u>Bowie State University</u> MIE	HQS/OEOP	\$649,786
--------------------------------------	----------	-----------

Summer Institute in Engineering and Computer Applications (SICA) Program	HQS/OEOP	\$179,391
---	----------	-----------

<u>Morgan State University</u> Engineering Enrichment Program	GSFC	\$60,000
--	------	----------

Graduate Training in Image Processing	HQS	\$115,000
---------------------------------------	-----	-----------

MISSISSIPPI

<u>Jackson State University</u> Pre-college Awards for Excellence in MSET	HQS/OEOP	\$99,985
---	----------	----------

NORTH CAROLINA

<u>Fayetteville State University</u> Graphing Calculator Institute	HQS/OEOP	\$49,997
---	----------	----------

<u>Winston-Salem University</u> JOVE	MSFC	\$28,000
---	------	----------

OHIO

<u>Central State University</u> Earth to Los Angeles	HQS/OEOP	\$357,775
---	----------	-----------

VIRGINIA

Hampton University

Educational Outreach for NASA Sciences and Applications	LaRC	\$480,056
---	------	-----------

Norfolk State University

Expanding Cooperating Hampton Roads Organizations for Minorities in Engineering (CHROME)	HQS/OEOP	\$96,000
--	----------	----------

New Activities

FLORIDA

Bethune Cookman College

Field Program Experience	KSC	\$26,000
--------------------------	-----	----------

Operation of Center for Space Education	KSC	\$318,617
---	-----	-----------

LOUISIANA

Xavier University

Training Grant	HQS	\$123,007
----------------	-----	-----------

MARYLAND

Bowie State University

Saturday School for Hispanic Females	GSFC	\$108,000
--------------------------------------	------	-----------

MISSISSIPPI

Jackson State University

Young Scientist Program	HQS	\$91,606
-------------------------	-----	----------

NORTH CAROLINA

Fayetteville State University

PACE/MSET	HQS	\$100,000
-----------	-----	-----------

<u>North Carolina A&T State University</u> Minority University Systems Engineering and Satellite Program	JPL	\$137,000
--	-----	-----------

TENNESSEE

<u>Meharry Medical College</u> NASA/Meharry Research Program	JSC	\$85,527
---	-----	----------

VIRGINIA

<u>Hampton University</u> Hampton University Aerospace Center	LaRC	\$300,000
--	------	-----------

Training Total		\$6,969,350
-----------------------	--	--------------------

NARRATIVE

During FY 1996, NASA continued to support training programs that develop resource pools of talented disadvantaged students, who are U.S. citizens, in NASA-related science, mathematics, engineering, and technology. Training is essential for NASA to meet its current and future human resources goals. Examples of some NASA training initiatives in FY 1996 include the following:

Mathematics, Science and Technology Awards for Teacher and Curriculum Enhancement Program (MASTAP)

The primary purpose of the MASTAP Program is to support institutions of higher education that increase the number and strengthen the skills of underrepresented minority mathematics, science and technology pre-service teachers who are prepared and state certified to teach in middle and high schools that have substantial enrollments of underrepresented minorities.

MASTAP grants provide up to \$200,000 for each of three (3) years of support for a total of up to \$600,000 per institutional grant with second and third year funding contingent on the availability of funds and acceptable progress toward program objectives, including monitoring and evaluation activities.

Currently there are MASTAP grants at the following HBCU's : Bennett College, Medgar Evers College, Shaw University, South Carolina State University, and Xavier University.

South Carolina State

University Share With a Pair of Peers Project (SWAPOP)

SWAPOP is a collaborative effort of pre-service/in-service minority science, mathematics and industrial technology education teachers with middle and high students. The project is designed to span three academic years, beginning the fall semester of 1995-96, continuing through the spring and summer semesters and ending the summer of 1998. During these years preparatory and experiential activities developed to accomplish the projects goals will take place. Examples of these will be: (1) the organization of a science, mathematics and technology education club (SMTE) at the university to serve as a center for recruiting, training, retaining and increasing the number of state certified minority teachers in the above named areas; (2) to develop an academic comradeship between pre-service and in-service teachers in the middle and high schools through specifically designed collaborative activities and (3) to provide summer program instruction and experiences that will develop and enhance the knowledge and skills of pre-service, in-service teachers and middle and high school students.

Precollege Awards for Excellence Program in Mathematics, Science, Engineering, and Technology Awards PACE/MSET

The primary purpose of the Precollege Awards for Excellence Program is to support research-based educational outreach projects that increase the number and strengthen the skills, knowledge and interest of underrepresented minority and disabled students in college preparatory mathematics, science and technology courses in public middle and high schools with substantial enrollments of minorities.

Eight grant awards will provide up to \$100,000 for each of three (3) years of support for a total of up to \$300,000, with second and third year funding contingent upon the availability of funding and acceptable progress toward program objectives, including monitoring and evaluation activities, as determined by NASA program staff

Edward Waters College

Math and Science Academic Enrichment Program

The NASA-sponsored *Math and Science Academic Enrichment Program* at Edward Waters College provides growth in academic and technical knowledge, self-confidence, and global awareness for minority high school students in the Jacksonville Florida community. Using a curriculum designed around an interactive series in Physics for grades 9-College, the program integrates course work in computers, mathematics, physics and electronics. The program offers conceptual physics and graduated electronic labs. Computers are used to access the rich Internet resources in order to research physics and electronics topics, enhance electronic skills using simulator software, and write computer programs to solve problems from math and physics classes. In addition to reinforcing

basic skills in Algebra and Geometry, math classes focus on subjects such as vectors and number systems

Trenholm State Technical College
High School Science Enrichment Program (HSSEP)

The NASA High School Science Enrichment Program (HSSEP) provides a productive and stimulating year-round learning environment that is directed toward increasing knowledge and skills toward encouraging young people, especially disadvantaged students, to seek a career in science. The program is implemented through a 7-week Summer Camp and two 9 to 12-week academic year Saturday Academies. These sessions are characterized by a “hands-on” group problem-solving approach to scientific learning. The Summer Camp focuses on building analytical, cognitive, and decision-making skills using mathematics, science and computer science applications. The Saturday Academy focuses on improving students’ understanding of subject concepts that will give the student an advantage position to improve grades and achievements.

NASA/University Joint Venture in Space Science (JOVE)

NASA/University Joint Venture in Space Science (JOVE) offers direct participation in space science research to a broad segment of faculty and students in the Nation's colleges and universities. The JOVE Initiative establishes research linkages that encourage institutions of higher learning to use the space program as a basis to involve both graduate and undergraduate students. Colleges and universities are also encouraged to establish outreach programs to precollege students in their regions. NASA makes space science data available to university researchers through an electronic data link, in exchange for the university providing faculty and students time to conduct research. Educational outreach programs are designed by the university to offer space science courses for high school students and summer space camps for student and teacher enrichment.

Model Institutions of Excellence (MIE)

NASA, in collaboration with the National Science Foundation (NSF), funds two of the six institutions selected as MIE’s, Bowie State University and Spelman College. The MIE’s were selected based on a competitive peer review process led by NSF. The primary goal for establishing MIE’s is to strengthen the science, engineering, and mathematics (SEM) baccalaureate degree-producing capacity of HBCU’s.

The Bowie State University’s Science, Engineering, and Mathematics Education (BSEME) Reform sets out to develop and institutionalize a strategy for improving educational and research opportunities for minorities in SEM fields. The program focuses on designing and implementing an outreach plan, expanding current linkages with area schools to increase the inflow of students into SEM fields, strengthening its mentoring and advisory programs for undergraduates, increasing the use of information systems and

interactive learning tools, and increasing links with Federal entities, industry, and other universities, especially the University of Maryland.

Spelman College's MIE award focuses on the retention of African American females in SEM disciplines. The program includes a revitalization of the SEM curriculum, modification of undergraduate research scope and capabilities, increased student development programs, and administrative infrastructure development. Spelman's MIE will complement its successful training project, Women in Science and Engineering (WISE).

PART II - AWARDS AND NARRATIVE INFORMATION

Category 4: Facilities and Equipment

There are no grants awarded specifically for Facilities and Equipment. A small portion of funding is normally permitted under a research or education grant to fund equipment required to support research or education activity. In addition, to the degree that it is available from the NASA Installations, HBCU's may be able to acquire excess or loaned equipment to support research efforts or scientific teaching.

Executive Order 12821, Improving Mathematics and Science Education in Support of the National Education Goals, signed November 16, 1992, by then-President Bush, authorizes Federal agencies to directly transfer excess education-related Federal equipment to public and private elementary and secondary schools. HBCU's having collaborative efforts with K-12 schools that have predominantly socially and economically disadvantaged and disabled student enrollments can become eligible to receive computer resources for training and outreach programs.

PART II - AWARDS AND NARRATIVE INFORMATION

Category 5: Fellowships, Internships, Traineeships, Recruitment, and Intergovernmental Personnel Act (IPA)

<u>HBCU/ACTIVITY</u>	<u>CENTER</u>	<u>AWARD</u>
Continuing Activities		
ALABAMA		
<u>Alabama A&M University</u>		
Graduate Student Researchers Program (GSRP)	MSFC	\$22,000
Research Program	MSFC	\$22,000
<u>Tuskegee University</u>		
Summer Employment Program	JPL	\$18,550
DISTRICT OF COLUMBIA		
<u>Howard University</u>		
Summer Faculty Fellowship Program (Aeronautics and Space Research)	HQS/OHRE	\$18,000
Minority Fellowship Program	JPL	\$40,477
Summer Employment Program	JPL	\$13,947
FLORIDA		
<u>Florida A&M University</u>		
Summer Employment Program	JPL	\$61,650
GEORGIA		
<u>Clark Atlanta University</u>		
Cooperative Education Program	JPL	\$13,205
Summer Employment Program	JPL	\$22,660

<u>Morehouse College</u> Summer Employment Program	JPL	\$14,201
---	-----	----------

<u>Spelman College</u> Summer Employment Program	JPL	\$11,767
---	-----	----------

MISSISSIPPI

<u>Jackson State University</u> Global Change Fellowship Program	HQS/OMTPE	\$22,000
---	-----------	----------

NORTH CAROLINA

<u>North Carolina A&T State University</u> Ronald E. McNair Graduate Research Fellowship Program	ARC	\$323,500
--	-----	-----------

Minority Fellowship Program	JPL	\$131,777
-----------------------------	-----	-----------

Summer Employment Program	JPL	\$8,446
---------------------------	-----	---------

Graduate Student Researcher Program (GSRP)	LaRC	\$22,000
--	------	----------

TENNESSEE

<u>Meharry Medical College</u> Graduate Student Researchers Program	HQS/OHRE	\$22,000
--	----------	----------

VIRGINIA

<u>Hampton University</u> Graduate Student Researcher Program (GSRP)	LaRC	\$22,000
---	------	----------

Summer Faculty Fellowship	LaRC	\$606,000
---------------------------	------	-----------

New Activities

FLORIDA

<u>Bethune Cookman</u> Faculty Fellowship	JPL	\$16,000
--	-----	----------

<u>Florida A&M University</u>		
Graduate Student Research Program	HQS/OHRE	\$464,806
Faculty Fellowship	JPL	\$16,000

LOUISIANA

<u>Dillard University</u>		
Summer Employment Program	JPL	\$3,006

NORTH CAROLINA

<u>North Carolina A&T State University</u>		
Career Fair and College Recruiting	JPL	\$5,586
Cooperative Education Program	JPL	\$12,672

Fellowships, Internships, Traineeships, Recruitment, & IPA's Total		\$2,234,760
---	--	--------------------

NARRATIVE

JPL's minority employees and minority summer interns are encouraged to apply for fellowships at HBCUs and other minority institutions to obtain graduate and undergraduate degrees in disciplines of particular interest to the laboratory. Programs include the JPL Minority Fellowship Program, the National Physical Science Consortium (NPSC), and the National Consortium for Graduate Degrees for Minorities in Engineering (GEM). JPL awarded \$172,254 in FY 1996 to participants in the Minority Fellowship Program.

Summer Employment Program

During FY 1996 JPL hired 120 students and faculty for summer employment. Of this number, 81 were underrepresented minorities (68%) and of this number 21 were from HBCUs. Students participating in the Summer Intern Program have the opportunity to work closely with JPL scientists and engineers on projects compatible with the students' academic discipline or scientific and engineering interests. Total expenditure for the program was \$154,227.

PART II - AWARDS AND NARRATIVE INFORMATION

**Category 6: Student Tuition Assistance, Scholarships,
and Other Aid**

<u>HBCU/ACTIVITY</u>	<u>CENTER</u>	<u>AWARD</u>
Continuing Activities		
ALABAMA		
<u>Tuskegee University</u> Summer Student Research Program	JSC	\$50,000
GEORGIA		
<u>Spelman College</u> USRP	HQS/OEOP	\$11,000
MARYLAND		
<u>Morgan State University</u> USRP	HQS/OEOP	\$12,000
MISSISSIPPI		
<u>Tougaloo College</u> NASA Summer Intern Pilot Program	HQS/OLMSA	\$26,407
Student Tuition Assistance, Scholarships, and Other Aid Total		\$99,407

NARRATIVE

Undergraduate Students Awards for Research program (USAR)

In FY 1996, NASA supported 55 students at 11 HBCU's in the Undergraduate Students Awards for Research program (USAR). The USAR awards provided tuition assistance,

summer research experience, and mentorship for students maintaining a minimum g.p.a. of 3.0 in academic fields of interest to NASA.

Fayetteville State Univ.	5	\$36,325
Florida A&M	2	\$17,000
Morehouse College	1	\$12,000
Morgan State University	10	\$120,000
North Carolina A&T	3	\$36,000
Shaw University	5	\$60,000
Southern University	5	\$60,000
Spelman College	11	\$132,000
Tennessee State Univ.	5	\$60,000
Tuskegee University	1	\$12,000
Winston-Salem State	2	\$24,000
Total Funding for FY 96	50	\$569,325

.

PART II - AWARDS AND NARRATIVE INFORMATION

Category 7: Direct Institutional Subsidies

NASA does not have any direct institutional subsidies.

PART II - AWARDS AND NARRATIVE INFORMATION

Category 8: Third-Party Awards

<u>HBCU/ACTIVITY</u>	<u>CENTER</u>	<u>AWARD</u>
Continuing Activities		
National Association for Equal Opportunity in Higher Education (NAFEO)	HQS	\$920,674
American Society for Engineering Education (ASEE)	HQS	\$100,000
Quality Education for Minorities (QEM) Network	HQS	\$ 49,856
New Activities		
The National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM)	HQS	\$301,000
Third-Party Awards Total		\$1,371,530

National Association for Equal Opportunity in Higher Education (NAFEO)

In FY 1996, NASA expanded the collaboration with NAFEO. Two NASA/NAFEO Faculty Development Workshops were conducted to provide representatives of HBCU's with information about NASA's goals, programs, and management directives.

The new start with NAFEO for FY96 was the Student Development component, which consisted of a 15 member Consortium of HBCU's. This new component identified 60 Student Researchers to receive tuition assistance and practical research experience to increase the production of technical degrees in fields required by NASA.

American Society for Engineering Education (ASEE) Helen T. Carr Fellowship

The ASEE Helen T. Carr Fellowship provides support to African Americans pursuing Ph.D.'s in engineering. Upon completion of the doctoral degree requirements, a fellow is committed to return to teach at an HBCU. The fellowships support students at eight Historically Black Engineering Colleges (HBECs) including Hampton University, Howard

University, Morgan State University, North Carolina A&T State University, Prairie View A&M University, southern University, Tennessee State University, and Tuskegee University. To date, the Helen T. Carr Fellowships have helped a select group of more than 20 African-American engineers earn their Ph.D.s. and join the faculty of one of the HBECs. since 1990, six NASA supported Helen T. Carr Fellows have earned their Ph.D.s and fulfilled commitment of joining the faculty at an HBEC. During FY 1996, OEOP continued to support 12 students through this program.

The National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc. (GEM)

In FY 1996, NASA began a collaborative with GEM to build the pool of under represented minorities and women successful in the NASA Graduate Student Researchers Program (GSRP). The GEM proposal included: graduate fellowships, summer internships, and enhanced mentorship. The goal is to achieve a 100% annual placement rate for 18 NASA scholars in Phd programs in science and engineering.

SHARP PLUS

In 1995 NASA and the Quality Education for Minorities (QEM) Network selected 300 high school students as participants NASA SHARP PLUS Research Apprenticeship Program. In FY 1996, NASA continues to support 10 HBCU's that were among 15 institutions of higher education selected to conduct SHARP PLUS research-based mentorship programs. FY 1996 funding for the program is \$481,000. Each HBCU site had 20 apprentices participating in research experiences in their campus laboratories and with industry partners. QEM administers SHARP PLUS for the Elementary and Secondary branch of NASA's Education Division of the OHRE. SHARP PLUS sets high academic standards and seeks to increase minority students' participation and success rates in challenging mathematics and science courses at the precollege level, thereby increasing the pool of well-prepared students for future professional careers in science and engineering-related fields.

PART II - AWARDS AND NARRATIVE INFORMATION

Category 9: Private-Sector Involvement

<u>HBCU/ACTIVITY</u>	<u>CENTER</u>	<u>AWARD</u>
New Activities		
DISTRICT OF COLUMBIA		
<u>Howard University</u> CAMPOS/LACEY Memorial Scholarship	JPL	\$10,000
GEORGIA		
<u>Clark Atlanta University</u> CAMPOS/LACEY Memorial Scholarship	JPL	\$10,000
Total		\$20,000

NARRATIVE

OAO Corporation, an operational and engineering support contractor to the Jet Propulsion Laboratory, established the CAMPOS/LACEY Memorial Scholarship in 1989. Scholarships are awarded to local students with interest and demonstrated abilities in math and science disciplines. OAO Corporation convenes a selection committee comprised of local High School Counselors, educators, community advocates and JPL staff to assist in the selection of potential scholars. OAO provides the scholarship and JPL provides meaningful summer internships which enable students to apply theoretical underpinnings learned during the academic year in a laboratory setting under the guidance of a scientist or technical supervisor. The total funding provided by OAO Corporation from their profits in support of scholarships to HBCUs over the six year period of the program is \$378,500. This private sector support is commendable and greatly appreciated by the Pasadena community and JPL

The Small Spacecraft Technology Program at Stennis Space Center is conducted through a team approach with Hampton University and Morgan State University as members of a team which is lead by TRW and includes eleven other private firms.

PART II - AWARDS AND NARRATIVE INFORMATION

Category 10: Administrative Infrastructure

There are no specific funds allocated for support of the administrative infrastructure of HBCU's. NASA assumes that all of the activities, support, and initiatives referred to in other parts of this report will contribute indirectly to this important area. This certainly is anticipated through all of NASA's minority university institutional research and education awards such as Research Centers, Institutional Research Awards, and Mathematics and Science Awards for Teacher and Curriculum Enhancement Programs.

PART II - AWARDS AND NARRATIVE INFORMATION

Category 11: Other Activities

<u>HBCU/ACTIVITY</u>	<u>CENTER</u>	<u>AWARD</u>
Continuing Activities		
VIRGINIA		
<u>Norfolk State University</u> Preservice Teacher Conference	LaRC	\$99,040
New Activity		
<u>Other</u> Annual Awards Banquet for Atlanta University Dual Degree Engineering Program	JPL	\$2,335
Other Activities Total		\$101,375

NARRATIVE

NASA FIELD INSTALLATION SUMMARIES

Ames Research Center (ARC)

Ames Research Center strongly supports NASA's efforts to strengthen and develop aerospace research capabilities in HBCU's. Ames' modest HBCU performance was attributable to the major reorganization in management that took place during 1996. Ames will continue its support of minority educational, and research and development programs in 1997.

Dryden Flight Research Center (DFRC)

Dryden Flight Research Center (DFRC) collaborated with Historically Black Colleges and Universities (HBCU) to establish mutually beneficial research grants. During FY 96, grant were established at North Carolina A&T State University and Alabama A&M University. DFRC continues to monitor two FAR grants at Hampton University and Clark Atlanta University. DFRC works with Spelman and Morehouse to continue the NASA Training programs that have been in place since the late 1980's. During FY 96 DFRC supported seven undergraduate students with scholarships. DFRC participates in a variety of career fairs to recruit minorities for co-op and direct hire opportunities including the National Society of Black Engineers Conference, Prairie View A&M Career Fair, and the Spelman/Morehouse Orientation Conference.

Goddard Space Flight Center (GSFC)

One of the goals of the GSFC is to increase the geographic and cultural diversity of college and university students, faculty members, and institutions participating in space research activities. In FY 1996 the GSFC identified two programs as worthy of duplication in other agencies. The first is the Model Institute of Excellence (MIE) which is a joint agency project with the National Science Foundation (NSF). This program serves to assist the institution with developing infrastructure and an expertise in a research area for the center as well as institutionalizing improvements to the science, engineering, and mathematics curricula. The other program is the Minority University - Space Interdisciplinary Network (MU-SPIN) Program which has proven itself a success. Through using programs such as MU-SPIN, MIE, and FAR, GSFC has created a change in the infrastructure at participating HBCU's which will have a lasting impact on the research capabilities for its programs, faculty and students.

Jet Propulsion Laboratory (JPL)

In Fiscal Year 1996, JPL continued implementing programs to achieve the goals of strengthening the capability of HBCU's to provide quality education and to conduct first rate research. Although JPL supported a total of eleven HBCU's, a major portion of the funding went to support three universities, Clark Atlanta University, Florida A&M University, and North Carolina A&T State University. Also through the Minority

Fellowship Program, Summer Faculty Fellowship Program, Cooperative Education Program, and minority summer internship program, JPL enhanced the capabilities of minority faculty to contribute to accomplishing the NASA mission.

Johnson Space Center (JSC)

JSC continued to develop a successful and vital link with HBCU's in implementing Executive Order 12677. During FY 1996, JSC increased the production of highly skilled, underrepresented minorities in NASA-related fields by supporting over 209 students pursuing degrees in technical fields. The Center stimulated the development of consortia and joint efforts between industry, universities and government such as the High Energy Cells and Batteries research under the trilateral Space Act Agreement between JSC, Texas Southern University, and Energy Innovations, a private firm. Total HBCU funding for FY 1996 represents a nine percent decrease below the FY 1995 level. Much of the reduction is the result of program realignment and shifting of research topics and responsibilities. Limited budgets will continue to restrict HBCU activities. However, identification of additional fund sources will be an ongoing effort to increase selective support to participating HBCU's in space science and engineering initiatives at JSC.

Kennedy Space Center (KSC)

The John F. Kennedy Space Center (KSC) continues to reach out to HBCU's and is working very hard to involve academia in its technology transfer and commercialization and outreach processes. During FY 1996 the Center increased the number of students participating in summer internship programs. Many of those students were from HBCU's. For the first time six undergraduate student researchers participated in the summer program. Plans are to continue to reach out and include HBCU's in the Graduate Student Program and Summer Faculty Program as well.

Langley Research Center (LaRC)

The NASA Langley Research Center (LaRC) actively sought to strengthen and build on its established goals and objectives in its relationship with HBCU's for Fiscal Year 1996. As a direct result of LaRC funding of the Cooperative Program for Research and Curriculum Development in Earth Systems Science (Project ESS), Norfolk State University (NSU) has officially established an Atmospheric Science Program as an additional component of the NASA-funded Center for Materials Research. A newly formed partnership between Elizabeth City State University and the Roanoke River Valley Consortium in PACE/MSET, resulted in a program for students and teachers in five rural, economically disadvantaged, predominantly African-American public school systems in northeastern North Carolina. The program design includes four major components: training for 30 educators, programs for 300 eighth graders, 300 parental partnerships, and includes the involvement of 68 business/industry partnerships.

Lewis Research Center (LeRC)

The Lewis Research Center strives to be recognized as a premier Research and Development (R&D) organization which utilizes and rewards the skills and talents of all people, to the fullest extent possible. LeRC's funding goals for HBCU's in FY 96 were a minimum of \$3.45M in research grants and \$0.5M in fellowships, internships, student tuition, facilities and other aid. Lewis awarded 42 research grants to 16 HBCU's for a total of \$4.11M for FY 96, thus exceeding our goals. Lewis' decrease in total awards to HBCU's over the FY 95 period was \$424,067. In the area of fellowships, internships, student tuition, etc., Lewis awarded a total of \$511,249, thus meeting the FY 96 goals.

The continuous success of Lewis' HBCU's funding of research grants was due to the commitment of top Lewis management and adoption of a Lewis plan for HBCU's. Excellent cooperation, coordination, and interfacing among the Lewis managers and researchers resulted in the outstanding achievement for the fourth consecutive year of Lewis' goals and objectives.

Marshall Space Flight Center (MSFC)

During FY 1996 total awards increased by 45% from \$1.2M in FY 95 to \$2.2M in FY 96. HBCU programs are playing a major role in supporting the Center in achieving its objectives. MSFC is supported by three Centers of Excellence managed by HBCU's. These are Alabama A&M University Center for Hydrology, Soil Climatology and Remote Sensing, Fisk University Center for Photonic Materials and Devices, and Spelman College's Model Institute of Excellence.

Stennis Space Center (SSC)

SSC not only reached its goal of maintaining the current level of funding of research grants at HBCU's at 10% of the Center's total R&D expenditures, but significantly exceeded that goal. In FY 1996 HBCU's received 15% of the total SSC R%D funds awarded. Jackson State University received an award to implement remote sensing training and five HBCU's are now involved in the Small Spacecraft Technology Program. In addition 5 of the 21 (24%) personnel participating in the Summer Faculty, Resident Research programs, and JOVE programs were HBCU faculty.

Acronyms

Headquarters (HQS)

- Office of Equal Opportunity Programs (OEOP)
- Office of Aeronautics (OA)
- Office of Human Resources and Education (OHRE)
- Office of Life and Microgravity Sciences and Applications (OLMSA)
- Office of Space Science (OSS)
- Office of Mission to Planet Earth (OMTPE)
- Office of Space Access and Technology (OSAT)
- Office of Safety and Mission Assurance (OSMA)
- Office of Space Communications (OSC)

Ames Research Center (ARC) - Moffett Field, CA

Dryden Flight Research Center (DFRC) - Edwards, CA

Goddard Space Flight Center (GSFC) - Greenbelt, MD

Jet Propulsion Laboratory (JPL) - Pasadena, CA

Johnson Space Center (JSC) - Houston, TX

Kennedy Space Center (KSC) - Kennedy Space Center, FL

Langley Research Center (LaRC) - Hampton, VA

Lewis Research Center (LeRC) - Cleveland, OH

Marshall Space Flight Center (MSFC) - Marshall Space Flight Center, AL

Stennis Space Center (SSC) - Stennis Space Center, MS